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COMPARING FIBRE CONTENT IN FLAX STRAW FROM ACCESSION GROWN BY THE PGRC IN 2000 AND FROM F4 CROSSES GROWN BY THE CDC IN 2001 USING MANUAL AND NIR

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Final Report

Biolin Research Inc.

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Project Title: Comparing Fiber Content in Flax Straw from Accessions Grown by PGRC in 2000 and from F4 Crosses Grown by the CDC in 2001 using Manual and NIR Methods

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Abstract

The bast fiber content of the straw from 631 selected flax accessions grown in 2000 and 2001 by PGRC in Saskatoon and 49 selected flax F4 crosses grown by the CDC at Canora were estimated by retting and then extracting the bast fiber. The results showed that bast fiber contents in PGRC accessions varied from 0.9% to 45.9% and from 7.9% to 18.8% in Canora F4 crosses. This data will be used to develop new oilseed flax varieties elevated levels of fiber content and to improve a NIR system that can be used to rapidly estimate fiber content in flax straw.

Executive Summary

In October of 2001, Biolin Research Inc. ("Biolin") received funding from the Agriculture Development Fund ("ADF") of Saskatchewan Agriculture, Food and Rural Revitalization to determine the fiber content[1] of the 631 new and re-grown flax straw samples that Biolin had collected and stored from Plant Gene Resources of Canada ("PGRC") accession plantings in 2000 and 2001 and the content of 49 F4 lines that had been collected from the Crop Development Centre (CDC) crosses at Canora.

Sub-samples of each straw sample were prepared, retted and processed by staff of Biolin. Each sub-sample consisted of pieces of straw 19 cm long cut roughly 10 cm above the ground level. Most sub-samples consisted of 100 to 150 pieces that, when combined, made a bundle about 4 cm in diameter. Before retting, sub-samples of straw from the flax accessions and F4 crosses were scanned using a Near InfraRed (NIR) reflectance machine at the University of Saskatchewan. Once wavelength patterns from these samples were generated and collected in a computer database, the database of wavelengths generated by sub-samples was analyzed with computer software to find which wavelength combinations are correlated most highly with the percentage of bast fiber in each sub-sample as determined by the Biolin decortication method. The results were both compared and combined with a previously generated NIR database from Athens, Georgia to help develop a NIR protocol that can be used to quickly estimate the fiber content in unretted flax straw.

The results of processing the 631 accessions of PGRC showed bast fiber content ranging from a low of 0.9% to a high of 45.9% and from the 49 F4 crosses, bast fiber content ranged from a low of 7.9% to a high of 18.8%. Plant heights (without seed heads and roots) varied from a low of 8.0 cm to a high of 29.5 cm. Table 1 presents a summary of the distribution of fibers contents of the 631 accessions from PGRC and Table 2 presents a summary of the distribution of fiber contents of the 49 F4 crosses from the CDC. From a plant breeder's point of view, this information opens up a wide range of possibilities since it means that there is a wide range of fiber contents in the germplasm held in the PGRC collection, and the CDC flax breeding program has created new oilseed flax lines with a range of fiber contents.

This data will be used by flax breeders to develop new oilseed flax varieties for the Prairies with elevated or lowered levels of fiber content and will provide base data needed to develop a NIR system that can be used to rapidly estimate fiber content in flax straw and roughly cleaned fiber. The eventual development of a NIR system to measure bast fiber content should allow buyers and sellers of flax straw and roughly cleaned fiber to improve the transparency and fairness of their commercial transactions (i.e., a farmer producing straw with a higher fiber content should get a higher price for his straw) and to provide a cheap and reliable tool that can be used to improve the fiber yield and/or consistency of the products they are producing (i.e., processors should be able to quickly monitor the effect of different machinery settings on the cleanliness level of the fiber they are processing).

[1] The vast majority of cellulosic-based fiber in flax straw is found in the inner bark of the stem. This fiber is called "bast" fiber and is, for all applications except whole straw papermaking, the fiber of commerce. However, in addition to bast fibers there are tiny cellulosic fibers found in other parts of the stem. Although they are a relatively small percentage of the total cellulosic fiber found in flax stems, they can influence the yield, speed and quality of paper in a paper making process. Thus the total fiber content of flax straw is slightly higher than the bast fiber content. In this project, we estimated the bast fiber content and not the total fiber content because it is much easier to measure and most processors of flax straw are only interested in the bast fiber content.

Table 1. Distribution of Bast Fiber Content in 631 PGRC Accessions

Fiber Content	Number of Accessions	Portion of These Accessions
>30%	2	0.3%
25.0-29.9%	5	0.8%
20.0-24.9%	21	3.3%
15.0-19.9%	214	33.9%
10.0-14.9%	302	47.9%
<10%	87	13.8%

Table 2. Distribution of Bast Fiber Content of 49 Canora F4 Crosses

Fiber Content	Number of F4 Crosses	Portion of These F4 Crosses
>30%	2	0.3%
25.0-29.9%	5	0.8%
20.0-24.9%	21	3.3%
15.0-19.9%	214	33.9%
10.0-14.9%	302	47.9%
<10%	87	13.8%

The reader should keep in mind that bast fiber content is only one of the characteristics that determines the amount of fiber that can be produced from a given area of land. The reader is also reminded that the fiber contents that we report are based on the results of processing single rows of flax plants. The fiber content of straw taken from a single row of flax plants is often influenced by the genetics of the flax variety or line in question but it can also be very greatly influenced by other factors. Some of the variables that are very important but not considered here include the number of the flax plants in a given row and the average stem diameter of the flax plants. Soil fertility, growing conditions and level of maturity at straw harvest have also been shown to have a significant influence on, not only on the fiber content, but also on fiber quality. The mandate of this project was to look only at fiber content and not at fiber quality and hence, at this time, we can not make comments on the quality of the fiber that might be produced from different accessions and F4 crosses.

The detailed results of processing the 631 accessions gathered from PGRC and the 49 F4 crosses gathered from Canora have been printed out in Appendix A.

Background and Objectives

Background

Farmers in Western Canada seed 700,000 to 900,000 hectares of flax every year and produce 800 to 1,200 kg/ha of "salvageable" straw in a normal weather year. Only 10-15% of this straw is collected and used in the manufacture of specialty papers and plastic components. The flax straw that is not removed from the field, for these uses, is normally burnt or chopped and spread. Unfortunately burning creates negative environmental impacts and chopping and spreading has a financial cost.

Recent market surveys and on-going research indicates there are many potential products that could utilize flax fibers to compliment or replace glass, synthetic and cotton fibers. If flax fibers were used more extensively in such products, it would increase the demand for flax straw, reduce the amount of flax straw that is burnt, and increase farmers' income from growing flax.

Objectives

In October of 2001, Biolin Research Inc. ("Biolin") received funding from the Saskatchewan Agriculture and Food's ADF to:

1. Determine the fiber content in flax straw grown by the PGRC (Gene Bank) in 2000 and 2001 and from F4 crosses grown by the CDC in the year 2001;

2. To use the data and samples thus generated to develop a preliminary protocol that will build upon the collaborative work done to date with USDA in Athens, Georgia;

3. Help flax breeders make more desirable crosses in the future and to develop a commercially viable NIR system that can be used to quickly and cheaply measure the fiber content in flax straw.

Experimental Methods

- During harvest of the PGRC accessions, the cutting bar of the plot harvester was raised such that it just cut below the seed bolls. This was done to try and maximize the length of straw left standing to obtain an indication of the maximum yield of straw that could be obtained if flax was "straight cut" instead of being swathed. Straw was pulled out of the ground by hand after cutting with the plot harvester.
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- With the CDC F4 lines grown at Canora, Biolin's technician collaborated with the CDC technician/scientists to determine if our selected lines were the same as theirs. The plots were unthreshed if the lines Biolin had selected were in no conflict with the lines that the CDC had collected. If CDC had selected the line, it was cut and threshed in the field. The straw was pulled from the full single row of the selected lines. After the straw was pulled it was put inside labeled cardboard rolls or paper bags and put into storage.

- From each straw sample collected from the PGRC and Canora lines, a sub-sample bundle of straw 4 cm in diameter and 19.0 cm was cut 10.0 cm above the ground line. In cases where the accessions were very short, lengths less than 19.0 cm had to be cut closer to the ground line. After bundling, each sub-sample was bound with two elastic bands and tagged with a plastic-coated label.

- Each trial was retted separately in a warm water tank for four to six days until the results of the "Fried Shake Test" showed that the majority of bundles were optimally retted. This test involved placing fifteen pieces of retting straw, each approximately 10.0 cm in length, each from a different bundle, in fifteen test tubes half full of boiling water with one piece of straw in each test tube. The test tubes were stoppered and placed in a machine designed by Biolin Research to violently shake test tubes for fifteen seconds. After shaking, the straw in each test tube was visually scored for loose fibers on a whole number scale from "0" to "3" with "0" representing no loose fibers and "3" representing total loosening of all bast fibers on the stem. When the average score was above 2.8 and there were no "0" scores and at least twelve test tubes had a score of "3", the bundles in the batch were considered fully retted. The bundles were then taken out of the tank, rinsed in tap water and set in drying racks, next to heater fans, for approximately four days to dry.

- Dry bundles were weighed and the fiber was extracted using a reciprocating blade-type breaker/decorticator. The fiber was hand cleaned to the point where few or no shives were left. After cleaning, the fiber was weighed and placed in separate sample bags and labeled with a catalog number.

- Data from the above trials was entered into Excel spreadsheets, sorted and analyzed for statistically significant results using regression analysis with binary variables.

- A report was written summarizing what was done and what results were obtained

Results and Discussion

Straw from PGRC Accessions

Results

The results of processing the 631 accessions showed bast fiber content ranging from a high of 45% to a low of 2%. Table 3 presents a summary of the distribution of fiber contents of the 631 accessions and Table 4 presents a summary of distribution of plant heights of the 631 accessions.

Tables A1 and A2 in Appendix A show the bast fiber content of all the accessions that were processed as well as data on dry unretted weights, wet retted weights, dry retted weights and the background identification information provided by PGRC. Equations A1, A2, A3 and A4 in Appendix A show that the shorter accessions had statistically significantly less fiber than the taller accessions and that accessions planted in 2001 has significantly less best fiber than those planted in 2000. This could be the combined result of drier weather in 2001 and/or a higher percentage of accessions planted in 2001 that have less genetic potential to produce bast fiber.

Table 3. Distribution of Bast Fiber Content in 631 PGRC Accessions

Bast Fiber Content	Number of Accessions	Portion of These Accessions
>30%	2	0.3%
25.0-29.9%	5	0.8%
20.0-24.9%	21	3.3%
15.0-19.9%	214	33.9%
10.0-14.9%	302	47.9%
<10%	87	13.8%

Table 4. Distribution of Plant Heights of 631 PGRC Accessions

Plant Height	Number of Accessions	Portion of These Accessions
>23.0cm	3	0.5%
19.5-23.0cm	90	14.3%
18.5-19.5cm	273	43.3%
15.0-18.5cm	218	34.5%
<15.0cm	47	7.4%

The reader should keep in mind that bast fiber content is only one of the characteristics that determines the amount of fiber that can be produced from a given area of land. The reader is also reminded that the fiber contents that we report are based on the results of processing single rows of flax plants. The fiber content of straw taken from a single row of flax plants is often influenced by the genetics of the flax variety or accession in question but it can also be very greatly influenced by other factors. Some of the variables that are very important but not considered here include the number of the flax plants in a given area and the average stem diameter of the flax plants. Soil fertility, growing conditions and level of maturity at straw harvest have also been shown to have a significant influence on, not only on the fiber content, but also on fiber quality. (The mandate of this project was to look only at fiber content and not at fiber quality and hence, at this time, we can not make comments on the quality of the fiber that might be produced from different accessions.) Since each accession is grown in a single row, the data we present are based on the results of the interactions of genetics, density of plants, soil moisture and fertility, etc.

In normal plot work, each accession would be planted in three or four replicated plots at several locations over a number of years before results would be published. In this project, we could only collect straw from one row grown in one year at one location. This means that environmental conditions can have a very big effect on the resultant fiber content and hence the fiber content that we show should be thought of in relative terms and not in absolute terms. In other words, if one accession has a fiber content of 30% and another has a fiber content of 10% there is a very good chance that the first accession has the genetic potential to produce much more fiber than the second accession and

hence the data we publish will help pinpoint accessions that are likely, but not certain, to have high fiber content, medium fiber content or low fiber content. However, when the difference in our published fiber content between two accessions gets to be less than 10%, there is much less certainty that this difference is due to genetics. One of the accessions may have just happened to be in a micro-location that had more soil nutrients or moisture that were beneficial for fiber production. Thus the closer the fiber contents of two accessions are, the less likely it is that any differences in fiber content are due to genetics.

In this project, one of the only indications we have of how much variation in fiber contents may be caused by differences in micro-environmental conditions is by looking at the fiber contents of the check variety *Vimy*. This variety was grown every 20 rows to give PGRC staff a way to compare the performance of nearby lines with a check variety that should be genetically the same throughout all the hundreds of test rows. Staff of Biolin Research collected and analyzed the straw from these *Vimy* check rows in 1998, 1999, 2000 and 2001. The results of this analysis are shown in Table 5. The fiber content decreased and the coefficient of variation (CV) increased in the later years. This may be due to a decrease in soil moisture, growing season rainfall and/or a decrease in soil fertility from 1998 to 2001. It could also be due to less viable seed, lower seeding rates and/or lower plant emergence in latter years. Although we cannot say for sure what were the causes, we can note that even the same variety grown in the same year in single rows within a 100 meters of each other can have different fiber contents and that these fiber contents can also vary with the year even though the general location is the same.

Table 5. Comparison of the Fiber Contents of *Vimy* Grown as the "Check Variety" over a Four Year Period at the Same PGRC Location

Accession Yr	Number of Vimy Samples Tested	Fiber Content of Unretted Fiber (%)	StDev	CV
1998	1	16.5%	N/A	N/A
1999	5	16.3%	1.7%	10.5%
2000	28	15.3%	3.1%	20.4%
2001	8	14.2%	4.1%	29.0%

Table 6 shows the estimated bast fiber content of some common Canadian oilseed flax varieties. Some of the accessions had been grown one to five times within the two years in question and, in these cases, Biolin collected one to five samples of straw with the same accession name. The results of analyzing these replicates showed that, on the average, the bast fiber content of straw with the same accession name had a standard deviation of 2.5 percentage points (e.g., 15.0% $\pm$ 2.5%). Thus it is likely in field situations that the varieties with the higher fiber contents in Table 6 will, in most cases, have higher fiber contents than those at the bottom of the list. Although the raw data does not support tests of statistical differences, it gives some indication of the variability that may be expected because of genetic differences. (i.e., In a field situation, factors like planting density, growing conditions and soil fertility can also have a significant effect on the bast fiber yield.)

Table 6. The Bast Fiber Content of Selected Canadian Oilseed Flax Varieties Grown by PGRC from 1998 to 2001

Cultivar	Fiber Content of Unretted Fiber (%)							Index Field Average = 100			
	1998	1999	2000	2001	AVG	STDEV	CV	1998	1999	2000	2001
AC Carnduff	N/A	18.9%	N/A	N/A	18.9%				109		
AC Emerson	N/A	18.3%	N/A	11.3%	14.8%	5.0%	33.5%		105		90
AC Linora	N/A	14.2%	N/A	N/A	14.2%				82		
AC McDuff	N/A	15.4%	N/A	N/A	15.4%				88		
AC Watson	N/A	19.1%	N/A	N/A	19.1%				110		
Andro	N/A	18.8%	N/A	N/A	18.8%				108		
Arg. 8C x B. Golden	N/A	N/A	16.3%	N/A	16.3%					115	
B. Golden x Ottawa	N/A	N/A	16.4%	N/A	16.4%					115	
Blanc	N/A	17.5%	N/A	N/A	17.5%				101		
C.A.N. 105 770B x Arg. 8C (Arrow x 975)	N/A	16.5%	N/A	N/A	16.5%				95		
C.A.N. 67-3901B	N/A	16.1%	N/A	N/A	16.1%				93		
CDC Arras	N/A	19.4%	N/A	N/A	19.4%				111		
CDC Bethune	N/A	17.0%	N/A	N/A	17.0%				98		
CDC Triffid	N/A	15.5%	N/A	N/A	15.5%				89		
CDC Valour	N/A	N/A	13.9%	N/A	13.9%					98	
Cirrus	13.3%	N/A	N/A	N/A	13.3%			90			
Cree	N/A	15.4%	16.0%	10.1%	13.9%	3.3%	23.7%		89	113	80
Crown	N/A	18.2%	N/A	N/A	18.2%				104		
Cyprus	N/A	15.9%	N/A	N/A	15.9%				91		
Dakota x Crystal-Bison (4265E)	N/A	N/A	16.8%	N/A	16.8%					118	
Diadem	N/A	19.7%	N/A	N/A	19.7%				113		
Dufferin	17.0%	N/A	15.5%	15.9%	16.1%	0.8%	4.9%	115		109	127
Flanders	N/A	20.9%	19.5%	N/A	20.2%	1.0%	4.8%		120	137	
F.P. 698	15.1%	N/A	N/A	N/A	15.1%			102			
FP 980	N/A	16.5%	15.6%	N/A	16.0%	0.6%	3.9%		95	110	
FP976	N/A	20.4%	19.7%	N/A	20.1%	0.5%	2.4%		117	139	
Fr 646	N/A	N/A	N/A	9.4%	9.4%						75
Fr 681	N/A	N/A	N/A	11.4%	11.4%						91
Hera	N/A	N/A	13.7%	N/A	13.7%					96	
J.W.S.	14.0%	N/A	N/A	N/A	14.0%			94			
J.W.S. 143B9 x Repetible-Viking	N/A	15.5%	11.2%	N/A	13.3%	3.0%	22.7%		89	79	
LaPlata C	N/A	17.9%	N/A	N/A	17.9%				103		
li2-12	N/A	N/A	N/A	12.8%	12.8%						103
Linott	N/A	17.3%	13.3%	N/A	15.3%	2.8%	18.5%		99	93	
Liral Crown	15.3%	14.5%	N/A	N/A	14.9%	0.5%	3.6%	103	84		
Liral Dominion	N/A	18.8%	N/A	N/A	18.8%				108		
Liral Monarch – Ottawa	14.6%	15.8%	N/A	N/A	15.2%	0.8%	5.3%	98	91		
Mcgregor	N/A	N/A	14.0%	10.8%	12.4%	2.3%	18.4%			99	86
Natasja	N/A	N/A	N/A	16.7%	16.7%						134
no name	N/A	17.7%	N/A	N/A	17.7%				102		
Noralta	N/A	N/A	19.1%	N/A	19.1%					134	
Normandy	N/A	16.0%	14.2%	9.2%	13.1%	3.6%	27.1%		92	100	73
Ottawa 2152	N/A	16.8%	N/A	N/A	16.8%				97		
Ottawa 770B	N/A	17.3%	N/A	N/A	17.3%				99		
Ottawa 829-C	N/A	16.0%	N/A	N/A	16.0%				92		
Raja	N/A	N/A	16.3%	N/A	16.3%					115	
Redwing	N/A	18.4%	14.9%	16.3%	16.5%	1.7%	10.5%		105	105	130
Redwood 65	N/A	22.3%	N/A	N/A	22.3%				128		
Rocket	N/A	21.0%	21.1%	N/A	21.1%	0.1%	0.3%		121	148	
Rocket 4	13.0%	15.9%	17.7%	N/A	15.5%	2.4%	15.2%	88	91	124	
Roja	N/A	N/A	15.2%	N/A	15.2%					107	
Roja Line 8	N/A	N/A	N/A	12.1%	12.1%						97
Royal	N/A	N/A	16.1%	N/A	16.1%					113	
Sel. of Clli-1098 (C5)	N/A	N/A	16.5%	N/A	16.5%					116	
Sel. of Clli-1220 (C4)	N/A	N/A	14.9%	N/A	14.9%					105	

Sel. of Clli-1441-A	N/A	N/A	9.5%	N/A	9.5%					67	
Sel. of Clli-1441-B	N/A	N/A	14.0%	N/A	14.0%					98	
Sel. of Clli-1472 (C4)	N/A	N/A	10.7%	N/A	10.7%					75	
Sel. of Clli-1484 (C4)	N/A	N/A	11.9%	N/A	11.9%					84	
Sel. of Clli-1493 (C4)	N/A	N/A	16.2%	N/A	16.2%					114	
Sel. of Clli-1650 (N)	N/A	N/A	11.5%	N/A	11.5%					81	
Sel. of Clli-1650 (S)	N/A	N/A	13.6%	N/A	13.6%					96	
Sel. of Clli-1650 (T)	N/A	N/A	14.5%	N/A	14.5%					102	
Sel. of Clli-1760 (C4)	N/A	N/A	8.9%	N/A	8.9%					62	
Sel. of Clli-1789 (C4)	N/A	N/A	10.1%	N/A	10.1%					71	
Sel. of Clli-1856 (C4)	N/A	N/A	11.4%	N/A	11.4%					80	
Sel. of Clli-1921 (C4)	N/A	N/A	14.1%	N/A	14.1%					99	
Sel. of Clli-1923 (C4)	N/A	N/A	14.7%	N/A	14.7%					103	
Sel. of Clli-1993 (C4)	N/A	N/A	13.0%	N/A	13.0%					92	
Sel. of Clli-2032 (C4)	N/A	N/A	16.8%	N/A	16.8%					118	
Sel. of Clli-2090 (C4)	N/A	N/A	10.0%	N/A	10.0%					70	
Sel. of Clli-2144 (C4)	N/A	N/A	8.7%	N/A	8.7%					61	
Sel. of Clli-2156 (C4)	N/A	N/A	14.8%	N/A	14.8%					104	
Sel. of Clli-2213 (C4)	N/A	N/A	15.8%	N/A	15.8%					111	
Sel. of Clli-2214 (C4)	N/A	N/A	9.8%	N/A	9.8%					69	
Sel. of Clli-2283 (C4)	N/A	N/A	18.8%	N/A	18.8%					132	
Sel. of Clli-2289 (C4)	N/A	N/A	13.7%	N/A	13.7%					96	
Sel. of Clli-2384 (C4)	N/A	N/A	13.9%	N/A	13.9%					98	
Sel. of Clli-2424 (C4)	N/A	N/A	11.9%	N/A	11.9%					83	
Sel. of Clli-2495 (C5)	N/A	N/A	15.2%	N/A	15.2%					107	
Sel. of Clli-25 (C4)	N/A	N/A	12.0%	N/A	12.0%					84	
Sel. of Clli-2519 (C4)	N/A	N/A	12.6%	N/A	12.6%					88	
Sel. of Clli-2560 (C4)	N/A	N/A	15.6%	N/A	15.6%					110	
Sel. of Clli-2582 (C6)	N/A	N/A	15.2%	N/A	15.2%					107	
Sel. of Clli-2610 (C4)	N/A	N/A	14.2%	N/A	14.2%					100	
Sel. of Clli-2611 (C4)	N/A	N/A	13.8%	N/A	13.8%					97	
Sel. of Clli-2625 (C4)	N/A	N/A	14.6%	N/A	14.6%					102	
Sel. of Clli-2648 (C4)	N/A	N/A	12.7%	N/A	12.7%					89	
Sel. of Clli-2658 (C4)	N/A	N/A	13.0%	N/A	13.0%					92	
Sel. of Clli-2661 (C4)	N/A	N/A	17.5%	N/A	17.5%					123	
Sel. of Clli-2699 (C4)	N/A	N/A	13.9%	N/A	13.9%					97	
Sel. of Clli-2734 (C4)	N/A	N/A	13.2%	N/A	13.2%					93	
Sel. of Clli-2757 (C4)	N/A	N/A	16.8%	N/A	16.8%					118	
Sel. of Clli-2763 (C6)	N/A	N/A	12.6%	N/A	12.6%					88	
Sel. of Clli-2787 (C4)	N/A	N/A	8.2%	N/A	8.2%					57	
Sel. of Clli-684 (C4)	N/A	N/A	10.7%	N/A	10.7%					75	
Sel. of Kubanskij	N/A	N/A	13.5%	N/A	13.5%					95	
Sel. Of PGR-16082 (C4)	N/A	N/A	13.6%	N/A	13.6%					96	
Sel. of TMP-1172 (C4)	N/A	N/A	17.4%	N/A	17.4%					122	
Sel. of TMP-1706 (C4)	N/A	N/A	13.8%	N/A	13.8%					97	
Somme	N/A	15.5%	N/A	N/A	15.5%				89		
Vimy	16.5%	16.3%	15.3%	14.3%	15.6%	1.0%	6.6%	111	93	107	114
Field Average	**14.9%**	**17.4%**	**14.2%**	**12.5%**	**14.8%**	**2.0%**	**13.7%**	**100**	**100**	**100**	**100**

Straw from CDC F4 Crosses Grown at Canora

Results

The results of processing the 49 lines showed bast fiber content ranging from a high of 19% to a low of 8%. Table 7, Table 9 and Table 10 present summaries of different data that was collected on the 49

lines that were analyzed. The detailed results of processing the 49 F4 crosses have been printed out in Appendix A.

Table 7. Distribution of Bast Fiber Content of 49 F4 Crosses Grown at Canora in 2001

Plant Height	Number of F4 Crosses	Portion of These F4 Crosses
>23.0cm	3	0.5%
19.5-23.0cm	90	14.3%
18.5-19.5cm	273	43.3%
15.0-18.5cm	218	34.5%
<15.0cm	47	7.4%

Table 8. Average Full Row Straw Weights of 49 F4 Crosses Grown at Canora in 2001

	F4 Cross or F4 Series of Crosses	Full Row Wt (gm)	StDev	CV
/a	CDC Bethune//NorLin/Vimy	389.7		
/a	CDC Arras//NorLin/Vimy	358.5		
/a	McGregor/FP871//Vimy/FP907	338.5		
/a	CDC Valour//Flanders/FP926	298.4		
Average	CDC Bethune//Flanders/FP908	289.7	52.7	18.2%
/a	CDC Bethune//Somme/FP923	283.7		
/a	CDC Valour//Vimy/FP907	267.4		
Average	CDC Bethune//McGregor/FP871	251.1	52.8	21.0%
Average	McGregor/FP871//Somme/Flanders	248.3	48.4	19.5%
/a	CDC Valour//Somme/FP923	241.7		
Average	CDC Bethune//Vimy/FP907	224.1	60.3	26.9%
Average	CDC Arras//Somme/Flanders	218.0	57.6	26.4%
Average	NorLin/Vimy//McGregor/FP871	191.5	46.1	24.1%
Average	CDC Bethune//Somme/Flanders	183.1	32.1	17.5%
Average	CDC Normandy//Flanders/FP908	178.0	41.9	23.6%
/a	CDC Arras//NorlLin/FP871	165.9		
/a	CDC Valour//Flanders/FP908	164.8		

a/ Only one line of this Series was selected

Table 9. Average Unretted Straw Fiber Content of 49 F4 Lines Grown at Canora in 2001

	F4 Cross or F4 Series of Crosses	Unretted Straw Fiber Content (%)	StDev	CV
/a	CDC Valour//Flanders/FP926	18.8%		
/a	CDC Valour//Somme/FP923	16.9%		
/a	CDC Arras//NorLin/Vimy	16.8%		
Average	CDC Bethune//Flanders/FP908	15.9%	1.7%	10.8%
Average	McGregor/FP871//Somme/Flanders	15.1%	1.9%	12.5%
Average	NorLin/Vimy//McGregor/FP871	15.0%	1.8%	12.2%
/a	CDC Valour//Flanders/FP908	15.0%		
/a	McGregor/FP871//Vimy/FP907	14.8%		
Average	CDC Arras//Somme/Flanders	14.5%	3.3%	22.8%
/a	CDC Valour//Vimy/FP907	14.3%		
Average	CDC Bethune//Vimy/FP907	13.9%	2.1%	15.0%
/a	CDC Bethune//NorLin/Vimy	13.6%		
Average	CDC Bethune//Somme/Flanders	13.4%	2.8%	20.7%
/a	CDC Bethune//Somme/FP923	13.0%		
/a	CDC Arras//NorlLin/FP871	12.3%		
Average	CDC Normandy//Flanders/FP908	12.0%	2.8%	23.3%
Average	CDC Bethune//McGregor/FP871	9.9%	2.8%	28.5%
a/ Only one line of this Series was selected				

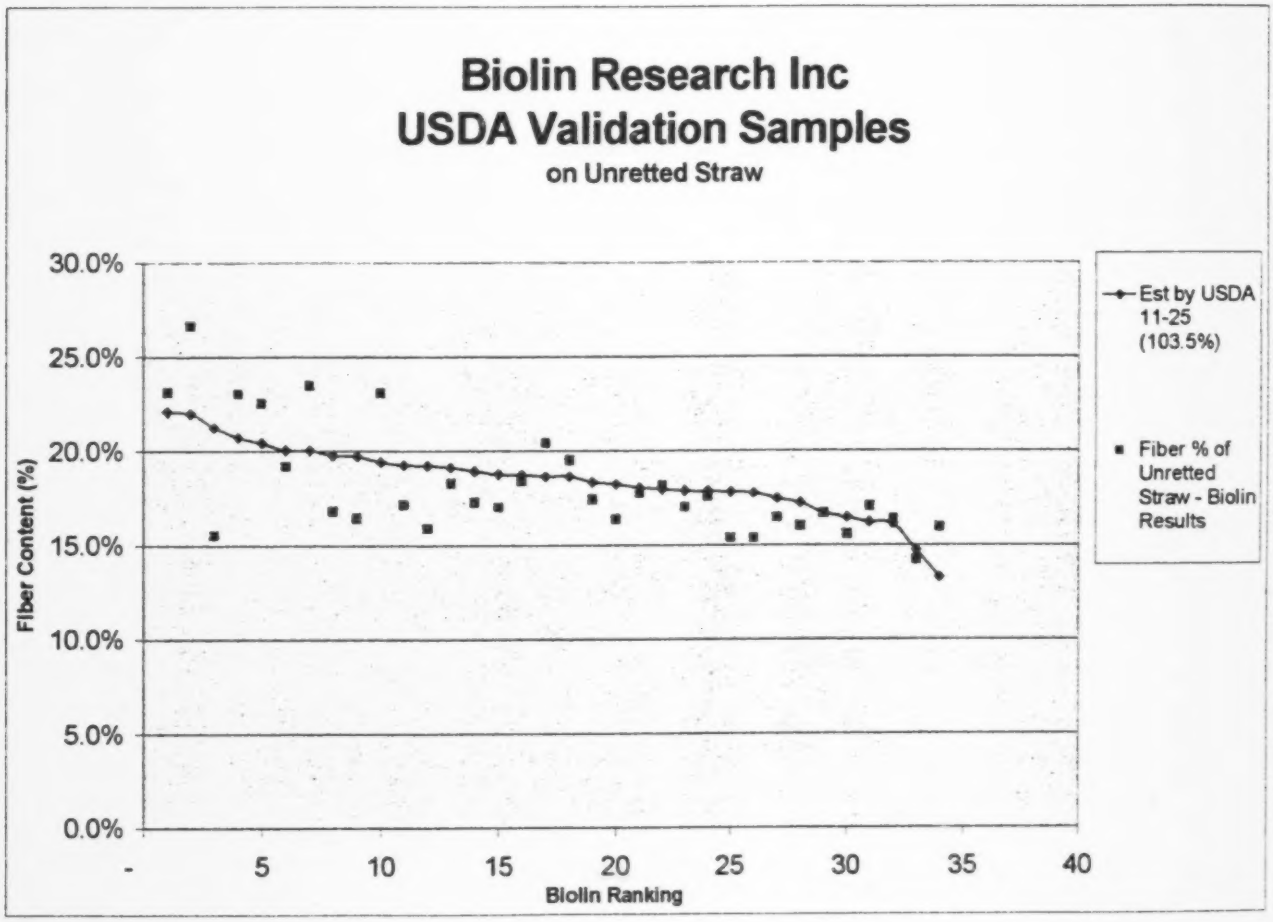
NIR Analysis

The Near InfraRed (NIR) methodology being used by the USDA Russell Research Lab in Athens, Georgia to estimate fiber content in flax straw was obtained along with the initial estimated equations which link NIR wavelengths to bast fiber in flax. These estimates were based on 200 samples of unretted flax straw and the subsequently extracted bast fiber that was supplied by Biolin Research in previous years. In the fall of 2001 we began working in collaboration with the University of Saskatchewan Crop Development Center (CDC) to adapt this methodology to work on a NIR machine owned by the CDC that is the same brand and model as the one used in the Athens lab.

Unfortunately the NIR machine in USDA lab in Athens that was used to do the original scans of unretted stems broke down after the original scans of 200 samples were taken. After it was repaired, scans of the flax straw from the F4 crosses from Canora were taken. However, the repaired NIR machine appears to send out slightly different wavelengths than previously and hence a correction

calibration function must be estimated and used. Due to a shortage of staff and more pressing commitments by the USDA lab in Athens, the appropriate correction calibration equation has still not been created. In the meantime, we have made some corrections to the original equations based on suggestions by the USDA NIR expert in Athens. The results of one of the better equations thus produced are shown in Figure 1 along with the actual results that Biolin obtained when physically processing the straw samples. The NIR equation that was used clearly shows a good correlation with the actual bast fiber content, but more fine-tuning will be required to improve the accuracy of the predictions.

Figure 1. USDA NIR-Based Predicted Bast Fiber Content Compared with Bast Fiber Content Determined by Biolin Research Inc.



Discussion

PGRC Accessions

The accessions represent a wide range of flax types and required different lengths of time for the seed to mature. Staff of PGRC have a primary mandate to re-generate seed for the Gene Bank and hence arrange harvest activities to maximize the chance of getting viable seed. This means that the seed bolls are harvested and the straw cut when the majority of accessions have reasonably mature seed. When this happens, all accessions are harvested within a few days, even though some may still not be fully mature. Differences in straw maturity can affect fiber content and/or the speed of retting since the fiber content increases and the fibers becomes more lignified (i.e., they ret more slowly) as the straw matures. The varying degrees of maturity between different accessions and the fact that we tank retted the straw samples in batches of approximately 48, meant that not all bundles were retted to the same degree. Hence some samples were much more difficult to process than others. It also means that our data may show slightly higher fiber contents for accessions that matured earlier. Some of accessions planted by the PGRC were from very old seed and produced relatively few plants in a single row. This may have also reduced the perceived bast fiber content of a particular accession.

Canora F4 Lines

With the drought conditions in Canora, plant growth at Canora was often sparse in single F4 rows. With little within row competition, such low plant densities tend to result in flax plants with many tillers and/or with thick stems which, in turn, tends to produce stems with lower fiber contents. This means that our data may show somewhat lower fiber contents for F4 crosses that produced only a few plants in a standard row length.

Improvement to NIR Protocol

Due to a shortage of staff at the Athens facility, work on the correction functions for the NIR equations are still not completed. We also found that the NIR machine in the Crop Development Science Department does not produce or read exactly the same wavelengths as the NIR machine in Athens, Georgia even though the machines are the same make and model. As an alternative to using the Athens lab generated NIR equation, we also generated our own equation using the Crop Science Department NIR machine. This resulted in an equation with an r^2 of 0.84 (compared to an r^2 of 0.91 on the Athens, Georgia machine after some data manipulation). The ultimate goal is to get an r^2 of 0.99 but NIR experts have told us this will take several more years of data, some further laboratory work regarding cleaning fibers more consistently and some further data manipulation. However, these NIR experts feel the existing equations can already be used to quickly identify straw with high fiber content for commercial straw processors since the chance of making an incorrect assessment is only 10 to 15% of all the samples tested. This bodes well for further calibration and commercialization of the NIR fiber determination method.

Conclusions and Impact

Conclusions

The clean fiber and shive samples produced during this project show that the bast fiber content of straw can be estimated with the method used by Biolin to carry out this project. There are now estimates of the bast fiber content of 1,409 of the accessions from 1998 and 1999 and bast fiber content of 631 of the accessions from the 2000 and 2001 growing seasons in the PGRC collection. Although the raw data supports tests of statistical significant differences in fiber content between growing years, it also gives a good indication of the wide variability that may be expected because of genetic differences in a single year.

Impact

From a plant breeder's point of view, this information opens up a wide range of possibilities since it means that there are large differences in fiber contents of flax accessions in the PGRC collection, With further refinement of NIR technology we will have a quick testing method to decide which lines to use to generate new crosses and lines. This should greatly assist in genetically elevating or lowering the fiber content of oilseed flax varieties bred for the Prairies.

The development of a NIR system to measure bast fiber content allows buyers and sellers of flax straw and roughly cleaned fiber to improve the transparency and fairness of their commercial transactions (i.e., a farmer producing straw with a higher fiber content should get a higher price for his straw) and to provide a cheap and reliable tool that can be used to improve the fiber yield and/or consistency of the products they are producing (i.e., processors should be able to quickly monitor the effect of different machinery settings on the cleanliness level of the fiber they are processing).

Information of Benefit to Processors and Government

Since this information shows that there is a wide range of bast fiber contents possible, it should encourage processors and/or governments to provide funding and/or other support to plant breeders to develop flax varieties for the Prairies with elevated or lowered levels of bast fiber content depending on the expected end use of the straw.

The knowledge that approximately 800 samples of calibration fiber and shive samples are now available to further develop a NIR system to quickly and cheaply measure bast fiber content in flax should encourage processors and governments to provide funds, if needed, to complete development of this method and/or to purchase and use NIR systems.

Need for Further Research

In most cases, the estimated bast content of a PGRC accession and a F4 cross was based on the straw produced from a single row planted to that accession or cross in one year at one location. Replicated, multi-location, multi-year trials should be set up with a selection of some of the accessions to get a clearer understanding of the natural variation that may occur in the bast fiber content of an accession or cross when it is grown in a variety of locations and weather patterns. Further work should also be done to investigate if accessions and crosses generally respond in the same way to changes in soil fertility, rainfall, planting rates, planting depth, etc. There is also a need to look at how bast fiber quality traits (e.g., fiber fineness, fiber strength) vary among flax accessions and crosses.

Appendix A

Appendix A contains a series of tables that shows the original or "raw" data results. These tables are as follows:

Table Name	Page
Table A1. PGRC Data From 2000 Crop Sorted on Fiber Content %	17
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Equation A1. Fiber % of Unretted PGRC Straw = f()	35
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Table A1. PGRC Data From 2000 Crop Sorted on Fiber Content %

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
3930	2000	TMP-2365	Buck 3	18.8	19.0	39.7	7.3	45.9%
4199	2000	TMP-9870	No name	18.5	48.4	41.0	6.2	39.7%
4137	2000	TMP-9811	Viking	66.4	19.0	54.0	17.5	27.6%
4108	2000	TMP-9783	Slavny-82	64.1	18.0	77.7	16.7	27.2%
4107	2000	TMP-9782	Aleksim	51.8	19.0	44.8	13.2	26.8%
4122	2000	TMP-9796	B-27	80.3	18.0	66.9	20.3	26.2%
4117	2000	TMP-9792	Tiame	78.2	18.5	66.5	18.9	25.1%
4148	2000	TMP-9821	6104-295	53.8	18.0	44.3	12.5	24.7%
4309	2000	TMP-2000	Slavnyj 82	76.4	20.0	74.4	18.2	24.7%
4109	2000	TMP-9784	Novotorzsky	77.1	18.5	64.8	17.9	24.1%
4119	2000	TMP-9794	D-1444-66	76.4	17.0	63.6	17.2	23.4%
4113	2000	TMP-9788	T-10	75.2	18.0	63.6	16.0	22.1%
4274	2000	TMP-8274	Comun de Diaz	8.7	12.0	7.7	1.3	22.0%
4139	2000	TMP-9813	Belinka	72.9	19.0	59.8	15.3	22.0%
4115	2000	TMP-9790	Stroitel	55.6	18.0	46.9	11.6	21.8%
4063	2000	TMP-8132	Kamaniza	18.1	19.0	18.1	3.3	21.6%
4223	2000	PGR-5040	Rocket	72.9	19.0	66.4	14.8	21.1%
4094	2000	TMP-8792	Redwing Sel	65.0	19.0	53.0	13.1	21.1%
3858	2000	TMP-8554	No name	49.7	18.0	41.7	9.9	21.1%
4230	2000	PGR-13076	Torzokskij 4	24.3	16.5	21.5	4.5	20.8%
4103	2000	TMP-1791	L-93-2	74.6	18.5	73.5	14.9	20.8%
3904	2000	TMP-2195	Ventnor	47.6	18.0	38.5	9.3	20.8%
4176	2000	TMP-9848	No name	79.2	20.0	67.5	15.5	20.4%
4206	2000	TMP-1720	Baladi	44.2	20.0	45.9	8.4	20.2%
4210	2000	TMP-1923	No name (China 5)	59.7	19.0	49.6	11.5	20.0%
4124	2000	TMP-9798	Millenium	61.5	20.0	50.4	11.6	19.8%
4303	2000	TMP-1026	FP976	52.0	18.0	43.8	9.7	19.7%
4161	2000	TMP-9833	Voronezcky-1308	58.4	19.0	48.4	10.9	19.6%
4058	2000	TMP-8054	Nostar - Rwd. x Crystal	60.3	19.0	68.6	11.3	19.6%
4010	2000	TMP-7733	II-29-20	48.1	18.0	42.5	8.9	19.6%
4105	2000	TMP-9780	Smolich	61.7	19.0	69.5	11.5	19.6%
4264	2000	TMP-7646	Minn. Sel. Winona x 770B F5	43.9	18.0	39.1	8.0	19.5%
4165	2000	TMP-9837	Flandres	58.7	17.9	65.9	10.9	19.5%
4174	2000	TMP-9846	No name	56.0	18.0	46.9	10.4	19.5%
4099	2000	TMP-8797	Jari Lan 241	45.3	19.0	36.7	8.2	19.3%
4209	2000	TMP-1922	No name (China 4)	97.7	20.0	96.1	18.2	19.2%
4126	2000	TMP-9800	Braginski krjazh	69.2	20.0	57.5	12.7	19.1%
4233	2000	PGR-14268	Noralta	23.1	18.5	19.9	3.9	19.1%
4147	2000	TMP-9820	Sortlo	62.3	17.0	52.2	11.4	19.1%
4111	2000	TMP-9786	Belochka	41.9	19.0	35.5	7.4	19.0%
4171	2000	TMP-9843	No name	49.8	19.0	50.1	8.9	19.0%

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
4026	2000	TMP-7916	112 x 389	53.1	19.0	47.7	9.6	19.0%
4241	2000	TMP-8360	SP 2271	36.4	17.5	29.5	6.4	18.9%
4216	2000	PGR-1717	Stavropolskij 79	64.9	19.0	53.0	11.7	18.9%
4051	2000	TMP-8000	Redwood x Cascade (56-3-42)	63.7	20.0	65.6	11.5	18.9%
4030	2000	TMP-7926	1134 x 1125-891-7-1	71.1	19.5	59.3	12.9	18.9%
3919	2000	TMP-10091	Sel. of CIli-2283 (C4)	60.3	19.0	60.1	10.8	18.8%
4118	2000	TMP-9793	Prometei-95	52.2	19.0	42.4	9.3	18.7%
3862	2000	TMP-8584	Kagalnitz Sel. Of 1351	59.1	20.0	63.5	10.5	18.6%
4000	2000	CHK	CHK - Normandy	38.1	19.0	32.6	6.6	18.6%
4224	2000	PGR-5042	Nynke	58.8	18.0	50.2	10.4	18.6%
4057	2000	TMP-8043	Redwood x Birio 33-6	61.7	19.0	49.5	10.9	18.6%
4104	2000	TMP-1821	Jere Parane INTA	89.0	19.0	71.5	16.0	18.6%
3897	2000	TMP-2184	Wiersema 43/45	58.9	19.0	53.9	10.4	18.5%
3820	2000	CHK	CHK – Vimy	55.8	19.0	57.5	9.8	18.5%
4151	2000	TMP-9824	Porkhosski krjazh	33.9	19.0	27.1	5.7	18.4%
4132	2000	TMP-9806	No name	55.8	18.0	46.3	9.8	18.4%
4220	2000	CHK	CHK – Vimy	58.7	19.0	51.1	10.2	18.3%
4135	2000	TMP-9809	L. Dominion	56.9	19.0	46.9	9.9	18.3%
3944	2000	TMP-2409	10407/46	41.7	19.0	34.8	7.2	18.3%
4307	2000	TMP-1900	Tai Chung SEL. No.1	67.0	19.0	58.7	11.7	18.3%
3804	2000	TMP-8373	No name	54.1	19.0	45.0	9.3	18.2%
4013	2000	TMP-7803	C.I. 355 x Bison	49.7	19.0	40.8	8.6	18.2%
3864	2000	TMP-8601	No name	46.7	19.0	39.5	8.0	18.1%
4162	2000	TMP-9834	Atalaute	57.1	20.0	50.8	9.8	18.1%
4120	2000	CHK	CHK – Vimy	63.7	20.0	69.0	11.0	18.1%
4266	2000	TMP-7706	No. 5242 - 1937	26.7	18.5	22.2	4.3	17.9%
3950	2000	TMP-2434	10437/46	44.0	18.0	37.8	7.4	17.8%
4201	2000	CHK	CHK – Vimy	53.4	18.5	60.9	9.0	17.8%
4242	2000	TMP-2177	Atlas (fiber)	36.2	18.0	30.4	5.9	17.8%
4128	2000	TMP-9802	Tulski krjazh	29.2	17.0	23.4	4.7	17.7%
4236	2000	PGR-16081	Rocket 4	59.1	18.0	56.0	9.9	17.7%
4101	2000	CHK	CHK – Vimy	51.7	19.5	50.1	8.6	17.7%
3895	2000	TMP-2179	Formosa	79.6	19.0	66.4	13.6	17.6%
4170	2000	TMP-9842	No name	56.9	20.0	58.1	9.5	17.6%
4123	2000	TMP-9797	Wiko	40.0	18.5	32.7	6.5	17.5%
4073	2000	TMP-10124	Sel. of CIli-2661 (C4)	37.9	19.0	30.1	6.2	17.5%
3908	2000	TMP-2211	210201 Fiber	55.8	19.0	53.6	9.2	17.4%
3880	2000	CHK	CHK – Vimy	62.5	18.0	60.2	10.4	17.4%
4202	2000	TMP-9871	No name	54.5	19.0	45.5	9.0	17.4%
3830	2000	TMP-10079	3W Winter Type	53.0	18.5	46.8	8.7	17.4%
4306	2000	TMP-10134	Sel. of TMP-1172 (C4)	37.1	18.5	32.8	5.9	17.4%
4049	2000	TMP-7990	No. 4	59.1	19.0	50.7	9.7	17.3%
4114	2000	TMP-9789	Tost	68.8	19.0	55.5	11.3	17.2%
4116	2000	TMP-9791	Nika	51.3	18.5	40.4	8.3	17.1%
3852	2000	TMP-8529	51W Winter type	56.1	19.0	58.3	9.1	17.1%
4258	2000	TMP-2987	No.Dak. Res. No. 52	28.0	19.0	22.6	4.3	17.1%

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
4080	2000	CHK	CHK – Vimy	60.3	20.5	53.0	9.8	17.0%
4155	2000	TMP-9828	Solezki krjazh	51.8	18.0	41.8	8.4	17.0%
4020	2000	CHK	CHK – Vimy	55.4	29.5	52.4	8.9	17.0%
3842	2000	TMP-8513	31W Winter type	79.4	18.5	69.3	12.9	16.9%
4001	2000	CHK	CHK – Vimy	60.3	20.0	49.8	9.7	16.9%
4036	2000	TMP-7949	116 x Redwood	56.1	16.5	47.2	9.0	16.9%
3855	2000	TMP-8537	Hosszuhati N.	56.1	18.5	46.7	9.0	16.9%
4100	2000	CHK	CHK – Normandy	50.1	20.0	45.0	8.0	16.9%
4077	2000	TMP-8331	Lino de Samare 1.8-4	68.7	20.5	54.4	11.1	16.9%
4172	2000	TMP-9844	No name	64.0	19.0	72.5	10.3	16.8%
4131	2000	TMP-9805	No name	66.1	18.0	54.6	10.7	16.8%
4056	2000	TMP-8035	Dakota x Crystal-Bison (4265E)	67.3	18.5	59.0	10.8	16.8%
3888	2000	TMP-10086	Sel. of CIli-2032 (C4)	69.4	18.0	82.5	11.1	16.8%
4267	2000	TMP-7714	Sel. of C.I. 385	48.2	19.0	44.2	7.6	16.8%
4299	2000	TMP10133	Sel. of CIli-2757 (C4)	41.4	18.0	33.5	6.4	16.8%
4246	2000	TMP-2224	111301 Fiber	52.8	19.0	43.9	8.4	16.7%
3909	2000	TMP-2219	83403 Fiber	51.2	18.0	48.8	8.1	16.7%
4029	2000	TMP-7925	Sel. from 1085 x 1134	82.7	20.0	64.6	13.3	16.7%
4275	2000	TMP-8360	SP 2271	28.5	16.0	22.7	4.3	16.7%
4110	2000	TMP-9785	Vasilek	83.5	19.0	80.9	13.5	16.7%
4133	2000	TMP-9807	No name	61.8	20.0	51.6	9.8	16.6%
4129	2000	TMP-9803	Stokinski krjazh	38.6	19.0	32.6	5.9	16.6%
4009	2000	TMP-7696	Sel. Rio x Buda	70.3	19.0	57.8	11.2	16.6%
4014	2000	TMP-10111	Sel. of CIli-1098 (C5)	40.2	18.0	32.6	6.2	16.5%
4096	2000	TMP-8794	No name	50.0	19.0	40.3	7.8	16.5%
4060	2000	CHK	CHK – Vimy	64.4	20.0	56.5	10.1	16.5%
3960	2000	CHK	CHK – Vimy	58.7	18.0	54.6	9.4	16.5%
3894	2000	TMP-2146	Tammes Sel. of2 White	58.6	18.0	48.6	9.2	16.5%
3998	2000	TMP-7665	Tammes Type 4	56.8	19.0	50.3	8.9	16.5%
4021	2000	TMP-7899	Victory B	47.4	19.0	41.7	7.3	16.4%
4018	2000	TMP-7897	B. Golden x Ottawa	43.7	18.5	34.7	6.7	16.4%
3863	2000	TMP-8594	Stepnoi	55.9	17.0	48.6	8.7	16.4%
3843	2000	TMP-8514	32W Winter type	54.9	18.0	55.5	8.5	16.4%
3956	2000	TMP-2472	10484/46	64.8	19.5	55.8	10.1	16.4%
4250	2000	TMP-2652	No name	50.2	18.5	41.5	7.8	16.4%
3958	2000	2491TMP-	Beladi	59.1	18.5	55.8	9.2	16.4%
4222	2000	PGR-5038	Raja	39.6	18.0	35.1	6.0	16.3%
4159	2000	TMP-9832	Legur	77.1	19.0	61.4	12.1	16.3%
4017	2000	TMP-7896	Arg. 8C x B. Golden	53.2	19.0	41.9	8.2	16.3%
4072	2000	TMP-8244	Colonia cambireta Safi-(13.440)	66.2	19.0	53.8	10.3	16.3%
4027	2000	TMP-7919	Wilden (389 x 25-8-1)	54.2	19.0	46.7	8.4	16.3%
4127	2000	TMP-9801	Velizhski krjazh	52.3	18.5	42.7	8.1	16.3%
4301	2000	CHK	CHK – Vimy	48.0	19.0	41.9	7.3	16.3%
4091	2000	TMP-8789	No.340	53.3	19.0	42.5	8.2	16.2%
3879	2000	TMP-10082	Sel. of CIli-1493 (C4)	16.0	19.0	12.7	2.1	16.2%
3980	2000	CHK	CHK – Vimy	68.1	18.0	62.0	10.6	16.1%
3903	2000	TMP-2192	Z 11637	48.5	20.0	40.2	7.3	16.1%

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
4292	2000	TMP-7678	Royal	42.0	18.0	42.4	6.3	16.1%
4015	2000	TMP-7860	Crystal x Redson, (II-41-2)	62.5	19.0	50.7	9.6	16.1%
4112	2000	TMP-9787	T-9	72.6	18.0	58.1	11.2	16.1%
4262	2000	TMP-7573	No name	20.2	20.0	16.9	2.8	16.1%
4219	2000	PGR-5035	Cree	62.1	19.0	51.6	9.5	16.0%
4190	2000	TMP-9861	S-MOBL	21.6	19.0	18.2	3.0	16.0%
3891	2000	TMP-2131	No name	65.1	19.5	52.1	10.0	16.0%
4200	2000	CHK	CHK - Normandy	44.4	19.0	40.8	6.6	16.0%
4141	2000	TMP-9814	Solido	63.6	18.0	51.6	9.7	16.0%
4079	2000	TMP-8345	Bison LN (67-I-46)	72.4	19.0	62.3	11.1	16.0%
3997	2000	TMP-7664	Tammes Type 3	40.8	19.5	32.5	6.0	15.9%
3949	2000	TMP-2430	10433/46	29.9	18.0	23.6	4.3	15.9%
4140	2000	CHK	CHK – Vimy	33.4	18.5	28.2	4.8	15.8%
3985	2000	TMP-10106	Sel. of CIli-2213 (C4)	20.5	17.0	17.9	2.8	15.8%
4003	2000	7670TMP-	Tammes Type 12	41.0	19.0	34.3	6.0	15.8%
3953	2000	TMP-2452	10460/46	46.0	20.0	36.9	6.8	15.8%
3945	2000	TMP-2410	10408/46	52.4	18.0	42.5	7.8	15.8%
4102	2000	TMP-8798	Lan proljetni BR 121	54.9	20.0	44.3	8.2	15.7%
4130	2000	TMP-9804	Votski krajazh	44.2	18.0	36.8	6.5	15.7%
4286	2000	0	Sel. of Kubanskij	41.0	17.5	33.7	6.0	15.7%
4024	2000	TMP-7913	389 x 1055-2	47.2	18.0	41.3	6.9	15.7%
4106	2000	TMP-9781	L-1120	46.9	20.0	37.8	6.9	15.7%
3821	2000	TMP-8449	No name	39.6	18.5	34.7	5.8	15.7%
3955	2000	TMP-2470	10482/46	50.3	18.5	44.1	7.4	15.6%
3838	2000	TMP-8507	25W Winter type	82.1	20.0	63.4	12.4	15.6%
3951	2000	TMP-2443	10447/46	34.6	18.0	29.3	5.0	15.6%
4194	2000	TMP-9865	No name	52.8	19.5	42.7	7.8	15.6%
4090	2000	TMP-8788	Currong	39.0	18.0	32.2	5.6	15.6%
4064	2000	TMP-10118	Sel. of CIli-2560 (C4)	107.0	20.0	89.4	16.3	15.6%
3893	2000	TMP-2142	Leucados 108	35.2	16.0	28.6	5.1	15.6%
4310	2000	TMP-2001	Torzhokshij 4	67.7	17.5	63.9	10.1	15.6%
4302	2000	TMP-868	FP 980	56.6	18.5	47.9	8.4	15.6%
4041	2000	TMP-7962	Leinho do Cuina	34.7	17.0	28.6	5.0	15.6%
4025	2000	TMP-7915	Clay	27.4	18.5	23.9	3.8	15.6%
4164	2000	TMP-9836	Ug Gegor	75.6	18.0	64.8	11.3	15.6%
3857	2000	TMP-8550	Newturk	70.0	18.5	53.0	10.4	15.5%
4234	2000	PGR-16078	Dufferin	48.6	18.0	40.9	7.1	15.5%
3957	2000	TMP-2475	No name	58.7	19.0	48.2	8.7	15.5%
3940	2000	CHK	CHK – Vimy	69.7	19.0	58.1	10.4	15.5%
3948	2000	TMP-2429	10431/46	56.5	17.5	51.0	8.3	15.4%
4198	2000	TMP-9869	noname	45.6	19.0	35.3	6.6	15.4%
4243	2000	TMP-2181	Hollandia	47.5	19.0	39.6	6.8	15.4%
4059	2000	TMP-8059	Crystal Hybrid 2-1	34.2	17.5	30.1	4.9	15.4%
3900	2000	CHK	CHK - Normandy	48.8	18.5	43.2	7.1	15.4%
3884	2000	TMP-2109	16W Winter type	38.3	18.5	31.8	5.5	15.4%
4153	2000	TMP-9826	Zaretski krjazh	30.9	19.0	25.5	4.3	15.4%
4087	2000	TMP-8785	No.3804	51.1	19.0	46.3	7.4	15.4%

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
3954	2000	TMP-2465	10477/46	46.9	18.0	39.0	6.7	15.3%
4257	2000	TMP-2985	Buda Sel.	55.1	19.0	44.9	8.0	15.3%
4006	2000	TMP-7679	Chinese Commercial	49.0	19.0	39.5	7.0	15.3%
4093	2000	TMP-8791	Roja	51.7	20.0	42.1	7.5	15.2%
4215	2000	PGR-1713	No name	46.3	18.0	39.8	6.6	15.2%
4276	2000	TMP-7702	Buda 80	45.2	18.0	43.1	6.4	15.2%
4166	2000	TMP-9838	Culbert	49.4	19.0	43.0	7.1	15.2%
4065	2000	TMP-10119	Sel. of CIli-2582 (C6)	37.9	19.0	28.9	5.3	15.2%
3890	2000	TMP-2130	No name	60.4	19.5	50.5	8.8	15.2%
4179	2000	TMP-9851	Siciliane-285	60.0	20.0	48.9	8.7	15.2%
3803	2000	TMP-8371	Roman Winter	53.8	18.5	57.1	7.6	15.2%
4061	2000	TMP-10116	Sel. of CIli-2495 (C5)	58.2	18.0	47.3	8.4	15.2%
3912	2000	TMP-2242	Talmune Fiber	63.8	20.0	54.8	9.2	15.1%
4273	2000	TMP-8273	Karnobat 1591 1.9	47.2	18.0	38.3	6.7	15.1%
4192	2000	TMP-9863	local	47.9	17.0	38.7	6.8	15.1%
4180	2000	CHK	CHK – Vimy	63.9	19.0	55.3	9.2	15.1%
4136	2000	TMP-9810	CB-PO-5	102.0	18.0	86.0	14.9	15.1%
3860	2000	CHK	CHK – Vimy	34.1	19.0	30.9	4.7	15.1%
4293	2000	TMP-7854	Renew x Redwing F5	29.4	18.0	25.9	4.0	15.0%
4218	2000	PGR-1725	Kirovogradskij 71	57.6	18.0	47.4	8.2	15.0%
4050	2000	TMP-7997	Sheyenne x C.I. 1332 (56-3-33)	39.6	19.0	33.0	5.5	15.0%
4098	2000	TMP-8796	Jari Lan ogulin Hrvatskc 241	42.2	17.0	35.9	5.9	15.0%
4238	2000	TMP-2087	No name	56.3	19.0	45.7	8.0	15.0%
4038	2000	TMP-7959	Crystal x C.I. 975	54.5	19.0	45.6	7.7	14.9%
3936	2000	TMP-10098	Sel. of CIli-1220 (C4)	34.9	17.0	29.2	4.8	14.9%
4226	2000	PGR-5052	Redwing	40.8	18.5	34.3	5.6	14.9%
4240	2000	CHK	CHK – Vimy	62.2	18.0	50.3	8.8	14.9%
4097	2000	TMP-8795	VNIIMK 620	47.2	17.5	38.5	6.6	14.9%
3889	2000	CHK	CHK – Vimy	55.2	19.0	42.6	7.8	14.9%
3827	2000	TMP-8475	Uruguay 36/49	56.5	18.5	57.3	8.0	14.8%
4054	2000	TMP-8031	Pernau	77.7	19.0	65.7	11.1	14.8%
4182	2000	TMP-9853	Np-55	20.8	19.0	17.6	2.7	14.8%
4321	2000	TMP-1920	No name (China 2)	52.4	18.0	44.9	7.4	14.8%
4265	2000	TMP-7684	Sel. of C.I. 161 (Nat. Hybrid)	50.8	18.5	45.6	7.1	14.8%
4084	2000	TMP-1717	L. Belyi	46.0	18.5	36.2	6.4	14.8%
4125	2000	TMP-9799	Argon	103.9	18.0	85.6	15.0	14.8%
3983	2000	TMP-10105	Sel. of CIli-2156 (C4)	59.6	18.0	63.0	8.4	14.8%
3841	2000	TMP-8509	27W Winter type	42.9	19.0	34.0	5.9	14.8%
4256	2000	TMP-2983	No. Dak. No. 40.013	63.6	18.0	53.4	8.9	14.8%
3807	2000	TMP-8376	No name	63.6	19.0	50.9	9.0	14.8%
4229	2000	PGR-13075	Natasja	45.3	19.0	37.2	6.3	14.8%
4196	2000	TMP-9867	No name	25.9	18.0	21.1	3.4	14.7%
3915	2000	TMP-2261	Cascade Fiber	83.1	18.5	68.1	11.8	14.7%
3886	2000	TMP-10085	Sel. of CIli-1923 (C4)	73.8	18.0	80.7	10.4	14.7%
3961	2000	2496TMP-	Benvenuto Reale	32.0	19.0	26.8	4.3	14.7%
3840	2000	CHK	CHK – Vimy	78.5	18.0	66.6	11.1	14.7%
4208	2000	TMP-1921	No name (China 3)	52.7	19.0	58.6	7.3	14.7%

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
3962	2000	TMP-2508	Uruguay 36/48	61.3	19.5	51.3	8.6	14.7%
3877	2000	TMP-1463	No name	34.5	18.5	28.0	4.6	14.6%
3845	2000	TMP-8520	39W Winter type	43.4	18.0	36.1	5.9	14.6%
4263	2000	TMP-7619	No name	40.5	20.0	32.9	5.5	14.6%
4221	2000	PGR-5036	Linott	50.3	19.0	41.9	6.9	14.6%
4048	2000	TMP-7989	No. 3	39.8	18.5	35.9	5.4	14.6%
4069	2000	TMP-10122	Sel. of CIli-2625 (C4)	32.5	18.5	26.9	4.3	14.6%
4191	2000	TMP-9862	local	56.4	18.0	51.6	7.8	14.6%
4046	2000	TMP-10115	Sel. of CIli-1650 (T)	70.7	18.5	58.6	9.9	14.5%
3868	2000	TMP-8626	Galego	33.2	15.5	26.7	4.4	14.5%
3826	2000	TMP-8471	Benvenuto Labrador	32.7	18.0	27.2	4.3	14.5%
4037	2000	TMP-7951	Towner	67.5	20.0	53.8	9.3	14.5%
3892	2000	TMP-2137	No name	28.1	17.0	23.3	3.6	14.5%
3952	2000	TMP-2451	10459/46	62.4	19.0	51.1	8.6	14.5%
4225	2000	PGR-5049	Reina	71.3	19.0	62.7	9.9	14.5%
4173	2000	TMP-9845	No name	80.8	18.0	67.0	11.3	14.4%
4034	2000	TMP-7946	975 x Crystal	59.5	18.5	50.0	8.2	14.4%
4138	2000	TMP-9812	Hermes	73.6	18.0	57.5	10.2	14.4%
4244	2000	TMP-2202	411704 Fiber	47.3	20.0	41.6	6.4	14.4%
3901	2000	CHK	CHK – Vimy	51.4	19.0	43.7	7.0	14.4%
4019	2000	TMP-7898	Victory A	46.6	19.0	38.2	6.3	14.4%
3935	2000	TMP-2386	10382/46	28.3	16.5	23.0	3.7	14.3%
4195	2000	TMP-9866	No name	60.2	19.5	47.9	8.2	14.3%
4261	2000	TMP-7553	No name	42.0	18.0	33.4	5.6	14.3%
3963	2000	TMP-2518	No. 1658	51.5	19.0	41.3	7.0	14.3%
3837	2000	TMP-8506	24W Winter type	37.1	19.0	32.6	4.9	14.3%
4066	2000	TMP-8190	Crocus	37.3	18.5	30.1	4.9	14.2%
4067	2000	TMP-10120	Sel. of CIli-2610 (C4)	33.3	18.0	27.5	4.3	14.2%
4011	2000	TMP-7740	Sel. 7, Rio x C.I. 36, F7	58.9	18.0	46.7	7.9	14.2%
4088	2000	TMP-8786	No.3861	54.5	18.0	46.9	7.3	14.2%
4160	2000	CHK	CHK – Vimy	63.5	18.0	55.7	8.6	14.2%
4319	2000	TMP-10137	H39/B La Plata	48.5	19.0	38.7	6.4	14.1%
3885	2000	TMP-10084	Sel. of CIli-1921 (C4)	51.8	17.0	48.5	6.9	14.1%
4228	2000	PGR-11967	Mcgregor	50.2	19.0	43.7	6.6	14.0%
4008	2000	TMP-7687	Renew	57.4	18.0	50.3	7.7	14.0%
3920	2000	CHK	CHK – Vimy	61.3	18.0	52.7	8.2	14.0%
4134	2000	TMP-9808	L. Sussex	40.0	20.0	34.1	5.2	14.0%
3818	2000	TMP-10077	Sel. of CIli-1441-B	42.3	18.0	33.2	5.5	14.0%
4144	2000	TMP-9817	Azur	64.4	18.5	52.5	8.6	14.0%
3848	2000	TMP-8523	42W Winter type	46.2	19.0	37.9	6.1	13.9%
4211	2000	TMP-1924	No name (China 6)	38.0	20.0	32.4	4.9	13.9%
4042	2000	TMP-7971	R.R. 5	30.3	18.0	25.1	3.8	13.9%
3969	2000	TMP-10100	Sel. of CIli-2384 (C4)	33.7	17.0	28.5	4.3	13.9%
3829	2000	TMP-8486	Szerepi	33.7	19.0	27.3	4.3	13.9%
4304	2000	TMP-1097	CDC Valour	54.6	18.0	49.1	7.2	13.9%
3881	2000	TMP-2088	No name	41.7	19.0	35.3	5.4	13.9%
4239	2000	TMP-2124	No name	44.7	17.5	35.6	5.8	13.9%

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
4075	2000	TMP-10125	Sel. of CIli-2699 (C4)	50.5	19.0	42.5	6.6	13.9%
3921	2000	TMP-2292	Bjelo Katjacs	35.3	19.0	29.8	4.5	13.8%
4083	2000	TMP-10129	Sel. of TMP-1706 (C4)	28.8	19.0	21.4	3.6	13.8%
3933	2000	TMP-2378	Klein 10e 10495/46	29.7	15.5	24.7	3.7	13.8%
4068	2000	TMP-10121	Sel. of CIli-2611 (C4)	19.3	18.0	15.5	2.3	13.8%
3926	2000	TMP-10095	B. Golden x Redwing (blue)	43.5	17.5	34.7	5.6	13.8%
3934	2000	TMP-2380	Klein 18 10493/46	40.5	18.5	31.6	5.2	13.8%
3914	2000	TMP-2251	SPI 238196 Fiber	55.8	18.0	46.3	7.3	13.7%
4152	2000	TMP-9825	Pechorski krjazh	32.0	19.0	27.6	4.0	13.7%
3932	2000	TMP-2370	Caxias	57.5	19.0	55.1	7.5	13.7%
4178	2000	TMP-9850	Ozimi Lan No.256	59.2	19.0	48.9	7.7	13.7%
3931	2000	TMP-2369	Farroupillia	39.4	18.0	31.6	5.0	13.7%
4305	2000	TMP-1154	Hera	67.3	18.0	56.7	8.8	13.7%
4253	2000	TMP-2713	No name	55.3	19.0	45.3	7.2	13.7%
4298	2000	TMP10132	Sel. of CIli-2289 (C4)	30.2	15.0	25.1	3.7	13.7%
4237	2000	TMP-10131	Sel. Of PGR-16082 (C4)	11.5	16.0	10.4	1.2	13.6%
4045	2000	TMP-10114	Sel. of CIli-1650 (S)	51.4	19.5	40.8	6.6	13.6%
3866	2000	TMP-10080	Redwing 92	59.5	19.0	47.9	7.7	13.6%
3861	2000	TMP-8574	No name	29.1	17.5	24.8	3.6	13.6%
4272	2000	TMP-8267	Bulgare a h	64.0	19.0	50.3	8.3	13.6%
3942	2000	TMP-2406	10404/46	34.4	18.0	28.3	4.3	13.5%
3959	2000	2495TMP-	Benvenuto Labrador	42.3	19.0	37.0	5.3	13.5%
3844	2000	TMP-8517	35W Winter type	29.9	19.0	24.8	3.6	13.5%
3941	2000	TMP-2397	10395/46	52.6	19.0	42.8	6.7	13.5%
3875	2000	TMP-1440	No name	63.3	20.0	54.8	8.2	13.4%
3947	2000	TMP-2422	10421/46	45.6	19.0	37.3	5.7	13.4%
4005	2000	TMP-7677	(19 x 112) 19	42.6	17.0	32.1	5.3	13.3%
4016	2000	TMP-7883	C.I. 975 x 1116	70.8	18.0	57.8	9.0	13.3%
3999	2000	TMP-7667	Tammes Type 6	43.7	19.0	37.8	5.4	13.3%
4076	2000	TMP-10126	Sel. of CIli-2734 (C4)	30.2	19.0	25.3	3.6	13.2%
3965	2000	TMP-2524	Luomal. Maatiais Yellow	41.5	15.0	36.1	5.1	13.2%
3859	2000	TMP-8559	No name	41.8	18.0	35.0	5.1	13.2%
4071	2000	TMP-8240	Safi 1.4-2-1	44.4	18.0	36.4	5.5	13.2%
4167	2000	TMP-9839	No name	36.2	16.0	28.7	4.4	13.1%
3814	2000	TMP-8419	No name	40.2	19.0	31.5	4.9	13.1%
4149	2000	TMP-9822	6503-559	82.5	18.0	69.1	10.4	13.1%
4039	2000	TMP-7960	Humpata	38.2	19.0	32.3	4.6	13.1%
4320	2000	TMP-10138	Sel. of CIli-2658 (C4)	26.0	18.5	20.0	3.0	13.0%
3976	2000	TMP-10101	Sel. of CIli-1993 (C4)	12.3	20.0	10.1	1.2	13.0%
3966	2000	TMP-2531	Pergamino Puelche	35.7	17.0	28.8	4.3	13.0%
3910	2000	TMP-10088	F/8/2 Fiber	41.1	18.0	32.8	5.0	13.0%
4023	2000	TMP-7911	Bowman	66.3	18.0	54.2	8.2	13.0%
4284	2000	0	Sel. of Kubanskij	43.9	17.5	35.0	5.3	12.9%
3823	2000	TMP-8464	No name	43.8	19.0	36.7	5.3	12.9%
3946	2000	TMP-2417	10415/46	32.3	19.0	27.0	3.8	12.9%
4247	2000	TMP-2467	10479/46	35.3	19.0	27.4	4.2	12.9%
3882	2000	TMP-2099	No name	56.0	18.0	44.6	6.9	12.9%

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
4053	2000	TMP-8009	1049	26.9	19.0	22.8	3.1	12.9%
4295	2000	TMP-2127	No name	53.4	19.0	43.2	6.5	12.9%
4325	2000	CHK	CHK – Vimy	44.4	19.0	34.7	5.4	12.9%
4040	2000	CHK	CHK – Vimy	41.8	18.5	34.2	5.0	12.8%
3808	2000	TMP-8380	Italia Roma	67.7	18.5	53.7	8.3	12.8%
4285	2000	0	Sel. of Kubanskij	58.4	19.0	44.7	7.1	12.8%
4297	2000	TMP-8367	Telva	33.6	17.0	27.2	3.9	12.7%
4318	2000	TMP-10136	36W Winter Type	53.3	18.5	42.6	6.4	12.7%
4142	2000	TMP-9815	Rastatter	87.2	19.0	69.8	10.7	12.7%
4070	2000	TMP-10123	Sel. of CIli-2648 (C4)	86.6	17.5	73.0	10.6	12.7%
4089	2000	TMP-8787	Querandi	51.2	18.0	42.3	6.1	12.7%
4280	2000	CHK	CHK – Vimy	53.0	20.5	46.1	6.3	12.7%
4186	2000	TMP-9857	No name	61.5	18.5	49.6	7.4	12.6%
4197	2000	TMP-9868	No name	43.4	20.0	31.9	5.1	12.6%
4082	2000	TMP-1706	Yan-Nun N 1	20.9	15.0	16.5	2.3	12.6%
3988	2000	TMP-10108	Sel. of CIli-2519 (C4)	23.5	18.0	20.1	2.6	12.6%
4078	2000	TMP-10127	Sel. of CIli-2763 (C6)	24.9	16.5	19.5	2.8	12.6%
4283	2000	0	Sel. of Kubanskij	55.7	18.5	43.7	6.6	12.5%
3938	2000	TMP-8365	10391/46	45.2	16.5	38.2	5.3	12.5%
4043	2000	TMP-7973	R.R. 38	28.6	18.0	23.6	3.2	12.5%
4278	2000	TMP-7584	No name	52.4	18.5	43.7	6.1	12.4%
3819	2000	TMP-8445	No name	51.7	17.0	41.1	6.0	12.4%
3822	2000	TMP-8460	No name	31.7	18.5	26.3	3.6	12.4%
3824	2000	TMP-8469	Beladi C.P.I. 8095	74.9	20.0	72.6	9.0	12.4%
4086	2000	TMP-8784	No.3837	35.9	18.5	30.6	4.1	12.4%
3977	2000	TMP-2787	N.P. 3	34.6	18.0	27.8	3.9	12.4%
3813	2000	TMP-10075	No name	58.7	19.0	49.6	6.9	12.3%
3902	2000	TMP-2191	Weira	28.9	18.5	28.0	3.2	12.3%
4193	2000	TMP-9864	local	54.7	18.0	44.2	6.4	12.3%
4168	2000	TMP-9840	Areco	53.5	19.0	47.9	6.2	12.2%
4189	2000	TMP-9860	1-01 1(ex v 437)	64.4	18.0	59.1	7.5	12.2%
4181	2000	TMP-9852	No name	67.4	20.0	52.9	7.9	12.2%
3906	2000	TMP-2209	210101 Fiber	87.2	18.0	70.5	10.3	12.2%
4092	2000	TMP-8790	No name	39.6	18.5	33.7	4.5	12.2%
3828	2000	TMP-8481	1285-S	40.6	20.0	31.5	4.6	12.2%
3887	2000	TMP-2127	No name	40.0	17.0	31.8	4.5	12.2%
4249	2000	TMP-2650	No name	16.9	16.0	12.6	1.7	12.1%
4035	2000	TMP-7948	Wells	54.5	19.0	45.7	6.2	12.0%
3872	2000	TMP-1404	No name	45.8	18.0	36.5	5.2	12.0%
3922	2000	TMP-10092	Sel. of CIli-25 (C4)	56.0	18.5	43.6	6.4	12.0%
4289	2000	TMP-7590	No name	35.4	19.0	30.5	3.9	12.0%
4232	2000	PGR-14267	Linott	44.4	20.0	36.8	5.0	12.0%
3802	2000	TMP-8369	Crete	20.4	19.5	16.5	2.1	11.9%
4033	2000	TMP-10112	Sel. of CIli-1484 (C4)	28.1	19.0	21.5	3.0	11.9%
4260	2000	CHK	CHK – Vimy	43.9	20.0	37.2	4.9	11.9%
3870	2000	TMP-10081	Sel. of CIli-2424 (C4)	38.8	14.0	36.8	4.3	11.9%
3873	2000	TMP-1408	No name	50.0	16.5	40.0	5.6	11.9%

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
4214	2000	PGR-1712	No name	58.7	18.0	49.5	6.6	11.8%
4074	2000	TMP-8263	HR E. La Estanzuela	30.9	19.0	24.1	3.3	11.8%
4012	2000	TMP-7745	Sel. 8. 1935. C.I. 36 x Bison, F7	35.9	18.5	28.7	3.9	11.8%
4308	2000	TMP-1998	No name	35.8	18.0	28.4	3.9	11.7%
4047	2000	TMP-7988	No. 2	54.1	19.0	43.3	6.0	11.7%
3878	2000	TMP-2078	No name	39.9	20.0	31.3	4.3	11.7%
4231	2000	PGR-13079	Mogilevskij	25.1	18.0	20.9	2.6	11.7%
4157	2000	TMP-9830	L. Prince	87.9	18.0	75.1	9.9	11.7%
3964	2000	TMP-2522	Recolte No. 0196	32.8	18.0	27.8	3.5	11.6%
4052	2000	TMP-8006	No. 205	36.6	18.5	28.6	3.9	11.5%
4044	2000	TMP-10113	Sel. of CIli-1650 (N)	43.6	17.0	34.0	4.7	11.5%
4163	2000	TMP-9835	Barbara	14.3	19.0	11.9	1.3	11.5%
4187	2000	TMP-9858	Balabi	40.4	18.0	32.6	4.3	11.5%
4269	2000	TMP-8168	W5623RO-24	20.0	18.0	16.4	2.0	11.5%
4294	2000	TMP-2057	Saidabad	29.1	17.5	23.5	3.0	11.5%
3967	2000	TMP-10099	Sel. of CIli-1856 (C4)	19.8	14.0	16.4	2.0	11.4%
4022	2000	TMP-7906	No. 1234	52.8	18.0	50.3	5.7	11.4%
3865	2000	TMP-8606	Irak 185	42.4	19.0	33.2	4.5	11.4%
3850	2000	TMP-8525	44W Winter type	24.9	16.0	20.1	2.5	11.3%
3918	2000	TMP-2289	Sorth Behbehan	52.4	20.0	40.4	5.6	11.3%
4169	2000	TMP-9841	Arangarde	38.3	19.5	30.0	4.0	11.3%
3984	2000	TMP-2914	N.P. (RR.) 5	15.1	27.0	13.3	1.4	11.2%
4032	2000	TMP-7942	J.W.S. 143B9 x Repetible-Viking	59.2	18.0	52.1	6.3	11.2%
4031	2000	TMP-7938	(Walsh Bulgarian) Bison (Golden x S.Golden)	28.0	18.5	21.7	2.8	11.2%
3968	2000	TMP-2605	La Prevision	36.0	19.0	28.7	3.7	11.1%
4287	2000	TMP-2157	No name	28.2	19.0	23.8	2.8	11.1%
4055	2000	TMP-8023	248921	44.7	20.0	35.0	4.6	11.0%
4270	2000	TMP-8216	Primus	35.5	18.0	28.7	3.6	11.0%
3835	2000	TMP-8502	20W Winter type	39.2	19.0	31.1	4.0	11.0%
4300	2000	CHK	CHK - Normandy	39.7	19.0	34.7	4.0	10.8%
3943	2000	TMP-2408	10406/46	37.9	19.0	30.9	3.8	10.8%
4158	2000	TMP-9831	VNIIMK	20.7	20.0	16.5	1.9	10.7%
3993	2000	TMP-10109	Sel. of CIli-684 (C4)	59.9	18.0	51.1	6.1	10.7%
4317	2000	TMP-10135	Sel. of CIli-1472 (C4)	22.7	20.0	17.9	2.1	10.7%
3833	2000	TMP-8498	15W Winter type	39.4	19.0	30.3	3.9	10.7%
3811	2000	TMP-8401	No name	30.0	18.5	23.5	2.9	10.6%
4185	2000	TMP-9856	local	40.3	18.0	33.2	3.9	10.5%
4277	2000	TMP-2678	248637	28.1	15.0	22.0	2.6	10.3%
3989	2000	TMP-2978	Res. x Hoshangabad (C.I. 19 x C.I. 140)	20.6	19.0	16.9	1.8	10.2%
3911	2000	TMP-10089	Sel. of CIli-1789 (C4)	29.6	18.5	24.5	2.7	10.1%
3815	2000	TMP-8430	No name	52.5	19.0	41.8	5.0	10.1%
4007	2000	TMP-7685	Leona	44.9	18.0	35.2	4.2	10.0%
3925	2000	TMP-2326	Sel. 12c12	34.8	16.0	27.7	3.2	10.0%
3981	2000	TMP-10103	Sel. of CIli-2090 (C4)	27.5	17.0	22.7	2.5	10.0%
3987	2000	TMP-10107	Sel. of CIli-2214 (C4)	19.6	14.0	16.9	1.6	9.8%
3871	2000	TMP-1396	No name	11.9	18.5	10.3	0.9	9.8%

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
4248	2000	TMP-2534	Chaurra Olajlen	36.2	19.0	28.6	3.3	9.7%
3923	2000	TMP-10093	Tammes Pale Blue	16.2	18.5	13.2	1.3	9.7%
4203	2000	TMP-9872	Karazygyr	55.7	18.0	43.7	5.1	9.7%
3817	2000	TMP-10076	Sel. of CIli-1441-A	13.4	18.5	11.4	1.0	9.5%
4291	2000	TMP-7663	Tammes Type 1	42.4	19.5	34.1	3.7	9.4%
3995	2000	TMP-7660	Smokey Golden No. 1846	37.2	18.0	30.3	3.2	9.3%
3867	2000	TMP-8610	Sadd's Engl. 97a	39.7	19.5	31.1	3.4	9.2%
3971	2000	TMP-2658	Sel. from C.I. 1802	17.7	12.5	15.4	1.4	9.2%
4004	2000	TMP-10110	Williston Brown	30.4	18.5	24.6	2.5	9.2%
4271	2000	TMP-8238	Erythree	27.2	19.0	21.7	2.2	9.1%
3854	2000	TMP-8535	248638	29.1	18.5	22.2	2.4	9.1%
4183	2000	TMP-9854	No name	39.0	19.0	29.3	3.2	8.9%
3907	2000	TMP-10087	Sel. of CIli-1760 (C4)	54.9	19.0	40.0	4.6	8.9%
3810	2000	TMP-8392	No name	41.5	18.5	31.9	3.4	8.8%
3869	2000	TMP-8643	Texas S. 32-1 Viking x Norsk	15.6	18.0	13.4	1.1	8.7%
3982	2000	TMP-10104	Sel. of CIli-2144 (C4)	16.5	15.0	15.1	1.2	8.7%
3972	2000	TMP-2692	Record	11.0	17.0	9.1	0.7	8.3%
4245	2000	TMP-2222	A/4 1/2 Fiber	30.5	18.0	23.3	2.3	8.3%
4002	2000	TMP-7668	Tammes Type 10	32.3	18.0	27.9	2.4	8.2%
4081	2000	TMP-10128	Sel. of CIli-2787 (C4)	32.5	20.0	24.9	2.4	8.2%
4252	2000	TMP-2681	248904	20.1	15.5	17.1	1.3	7.6%
3978	2000	TMP-2789	N.P. 8	10.9	16.5	9.0	0.6	7.5%
3973	2000	TMP-2735	Type 11	32.7	19.0	22.5	2.2	7.4%
4279	2000	TMP-2530	L.G. 0189B	37.3	19.0	33.9	2.5	7.4%
4311	2000	TMP-8663	CDC Normandy	31.9	19.0	27.3	2.1	7.2%
4251	2000	TMP-2679	248902	19.5	15.0	18.1	1.2	7.1%
4184	2000	TMP-9855	Punjab	28.8	18.0	23.3	1.8	6.9%
4288	2000	TMP-7589	No name	42.7	18.0	34.0	2.7	6.8%
3816	2000	TMP-8435	No name	37.0	19.0	28.7	2.2	6.5%
4254	2000	TMP-2724	No name	42.1	18.0	31.6	2.5	6.4%
4085	2000	TMP-1733	Mestnyi	15.1	15.0	12.1	0.8	6.3%
4217	2000	PGR-1721	Wir-1647	27.4	19.0	22.9	1.5	6.1%
3899	2000	TMP-2190	Percello Blue	24.3	21.0	20.3	1.3	6.0%
3970	2000	TMP-2645	PI 780	26.6	18.0	22.3	1.4	5.9%
3990	2000	TMP-7518	J.W.S. Fiber	14.4	13.0	13.1	0.6	5.4%
3916	2000	TMP-2280	Horal	26.2	20.0	19.6	1.2	5.3%
3996	2000	TMP-7661	N.D. 1844	19.5	14.0	16.9	0.8	4.7%
3974	2000	CHK	CHK – Vimy	7.5	14.0	6.9	0.2	4.3%
4175	2000	TMP-9847	No name	26.4	15.5	24.7	1.0	4.2%
3806	2000	TMP-8375	No name	11.1	14.0	9.9	0.3	3.6%
3924	2000	TMP-10094	Dehiscent	10.4	15.5	9.0	0.2	2.6%
4255	2000	TMP-2945	Neelum (3/2)	13.6	19.0	11.6	0.2	1.8%

Table A2. PGRC Data From 2001 Crop Sorted on Fiber Content %

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
4228	2001		CHK - Vimy	36.3	19.5	25.6	7.3	22.1%
4667	2001	TMP-10871	Rodnik	52.1	19.0	40.5	10.4	21.2%
5352	2001	PGR-13079	Mogilevskij	65.4	20.5	50.1	12.7	20.2%
5377	2001	TMP-10253	57W Winter type	49.0	19.0	38.5	9.0	19.3%
4631	2001	TMP-10837	KLN-1	42.4	20.0	51.0	7.6	19.2%
4578	2001	TMP-9902	Opaline	36.5	20.0	28.2	6.2	18.9%
5380	2001		CHK - Vimy	36.8	19.5	30.2	6.4	18.8%
4645	2001	TMP-10850	Raisa	41.6	18.0	31.9	7.1	18.6%
4646	2001	TMP-10851	Texa	29.2	18.0	21.4	4.8	18.3%
4630	2001	TMP-10836	Signal	46.8	18.5	35.9	7.9	18.0%
4633	2001	TMP-10839	G-1847-4-1	46.9	20.0	34.6	7.8	17.6%
4591	2001	TMP-10800	Torzhokskij 4	54.5	20.5	39.7	9.1	17.5%
4671	2001	TMP-10875	No name	55.1	20.5		9.1	17.5%
4632	2001	TMP-10838	G-1783-4-18	44.4	19.0	33.6	7.1	17.4%
4641	2001	TMP-10846	Diane	45.2	19.0	34.9	7.3	17.2%
4675	2001	TMP-10879	Tverskoy	41.5	19.5	28.7	6.4	16.9%
4686	2001	TMP-10889	L. 1200-4-3	46.9	17.0	34.7	7.5	16.9%
5365	2001	PGR-16079	Natasja	67.3	20.0	53.9	10.8	16.7%
4673	2001	TMP-10877	A-93	47.2	19.0	35.6	7.3	16.7%
4679	2001	TMP-10883	L. 00-187-60	32.2	19.0	25.5	4.9	16.6%
5347	2001	PGR-5052	Redwing	27.6	19.0	19.8	4.0	16.3%
4688	2001	TMP-10891	G-2741-5-5	26.9	18.0	21.1	3.8	16.3%
4650	2001	TMP-10855	Ariane	49.7	19.0	35.5	7.5	16.1%
4667	2001	TMP-10871	Rodnik	37.8	19.0	25.4	5.6	16.0%
5338	2001	PGR-1722	VNIIMK-5237	31.9	15.5	28.3	4.6	16.0%
4681	2001	TMP-10884	L. 270-68	30.8	18.5	23.5	4.5	16.0%
4626	2001	TMP-10832	Line 87287-7	61.4	21.0	46.3	9.3	15.9%
5376	2001	TMP-10252	49W Winter type	68.7	17.5	54.3	10.5	15.9%
5364	2001	PGR-16078	Dufferin	42.0	16.0	34.0	6.2	15.9%
4674	2001	TMP-10878	Lenok	33.0	20.0	25.9	4.7	15.8%
4584	2001	TMP-9907	Kastychiai	46.6	20.0	34.9	6.9	15.8%
4670	2001	TMP-10874	G-2101-4-7 Line 7	34.6	19.0	26.9	4.9	15.7%
4586	2001	TMP-9909	Olinette	28.6	18.5	20.7	4.0	15.6%
4579	2001	TMP-9903	Baltuchiai	36.5	20.0	28.2	5.1	15.5%
4634	2001	TMP-10840	Z 95197	40.8	20.0	30.4	5.9	15.5%
5335	2001	PGR-1716	No name	25.7	17.0	20.4	3.6	15.5%
4636	2001	TMP-10842	Z 95196	44.3	20.0	33.2	6.3	15.3%
5355	2001	PGR-14265	Cree	41.6	18.5	31.3	5.9	15.2%
4589	2001	TMP-9912	Vega 2	44.7	19.0	33.3	6.4	15.2%
4598	2001	TMP-10807	A27 B-1	49.6	20.0	39.5	7.1	15.2%
5399	2001	TMP-10089	Sel. of CIli-1789 (C4)	37.7	19.0	28.8	5.3	15.1%
4682	2001	TMP-10885	L. 222-68	32.9	19.0	24.2	4.6	15.0%
5363	2001	PGR-14272	Summit	48.2	19.0	34.4	6.8	15.0%
4629	2001	TMP-10835	K-65	55.9	20.0	42.2	7.9	14.8%
4582	2001	TMP-9905	Banga 2	25.6	19.0	19.5	3.3	14.7%
4687	2001	TMP-10890	L. 1344-4-1	24.5	16.5	19.3	3.2	14.7%

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
4689	2001	TMP-10892	L. 00-8	25.7	15.5	20.1	3.3	14.7%
5353	2001	PGR-14263	Bolley	32.7	18.0	25.3	4.4	14.7%
5351	2001	PGR-13075	Natasja	54.1	20.0	41.9	7.5	14.6%
5368	2001	TMP-8369	Crete	29.8	15.0	22.9	3.7	14.0%
5374	2001	TMP-8521	40W Winter type	73.8	19.5	58.6	9.9	14.0%
4655	2001	TMP-10860	No name	29.4	14.5	21.2	3.7	14.0%
4685	2001	TMP-10888	L. 81-4-1871	48.8	19.0	38.2	6.4	13.9%
4692	2001	TMP-10895	R-736	39.0	17.0	29.1	5.0	13.9%
4597	2001	TMP-10806	Zhodinskij	32.4	20.0	25.8	4.1	13.8%
4663	2001	TMP-10867	G-4729 Line 3	41.1	19.0	30.2	5.2	13.8%
5366	2001	CHK	CHK – Vimy	45.4	20.0	37.2	5.9	13.8%
5354	2001	PGR-14264	Ci2776	38.4	17.5	29.8	4.8	13.8%
4640	2001		CHK - Vimy	37.1	19.0	24.2	4.7	13.7%
4622	2001	TMP-10828	No name	30.7	20.0	23.1	3.7	13.7%
5413	2001	TMP-9786	Belochka	48.9	20.0	39.6	6.2	13.7%
4647	2001	TMP-10852	Marina	53.9	19.0	41.0	7.0	13.7%
5372	2001	TMP-8484	No. 15578	25.6	18.5	17.5	3.1	13.6%
4594	2001	TMP-10803	No name	69.3	20.0	51.5	9.0	13.5%
5336	2001	PGR-1718	Sibiriak	34.4	15.5	27.5	4.2	13.2%
4623	2001	TMP-10829	No name	26.9	18.0	20.1	3.1	13.2%
5378	2001	TMP-10254	Hosszuhati 7022	41.8	15.5	32.9	5.2	13.2%
5414	2001	TMP-9790	Stroitel	51.7	21.0	40.9	6.3	13.0%
4644	2001	TMP-10849	Line 4-2-1	45.4	17.0	34.1	5.6	13.0%
4757	2001	TMP-10052	Opaline	31.4	19.5	24.8	3.6	12.9%
4672	2001	TMP-10876	Svetoch	50.4	20.0	38.1	6.1	12.9%
5362	2001	PGR-14271	Redwing	38.5	17.0	30.2	4.6	12.9%
5422	2001	PGR-16082	Ii2-12	13.4	11.0	10.2	1.4	12.8%
5415	2001	TMP-9808	L. Sussex	37.2	20.0	28.9	4.4	12.8%
4624	2001	TMP-10830	No name	28.7	19.0	17.5	3.3	12.8%
4690	2001	TMP-10893	A-176	28.5	17.0	22.6	3.3	12.7%
4665	2001	TMP-10869	Currong Line 3	38.6	19.5	28.0	4.5	12.7%
4654	2001	TMP-10859	Minesota	25.4	14.5	20.0	2.8	12.7%
5397	2001	TMP-10099	Sel. of CIli-1856 (C4)	22.5	10.5	15.5	2.5	12.4%
4653	2001	TMP-10858	No name	28.6	17.0	17.6	3.2	12.3%
5340	2001		CHK - Vimy	37.4	19.0	26.1	4.2	12.3%
5407	2001	0	Selection of Winterlein	16.1	10.0	12.5	1.6	12.2%
4676	2001	TMP-10880	Zarjanka	36.3	18.5	24.5	4.0	12.1%
4664	2001	TMP-10868	Roja Line 8	36.3	18.5	27.3	4.1	12.1%
4638	2001	TMP-10844	Z 95199	70.3	20.5	46.2	8.1	12.1%
4596	2001	TMP-10805	No name	53.2	20.0	39.8	6.0	12.0%
4649	2001	TMP-10854	Clark	32.8	18.5	23.9	3.6	12.0%
4643	2001	TMP-10848	FCFL	52.1	19.5	39.6	5.8	12.0%
5416	2001	TMP-9830	L. Prince	41.0	20.0	32.1	4.6	12.0%
5406	2001	TMP-7661	N.D. 1844	26.1	14.0	20.5	2.8	12.0%
5379	2001	TMP-8610	Sadd's Engl. 97a	65.5	20.0	48.1	7.5	11.9%
4587	2001	TMP-9910	Upyte 2	44.9	20.0	35.7	5.0	11.9%
4593	2001	TMP-10802	No name	68.1	20.0	51.2	7.8	11.9%
5386	2001	TMP-10567	Sel. of CIli-2082 (C2)	26.1	10.0	20.2	2.8	11.9%
5370	2001	TMP-11341	No name	38.8	17.0	29.2	4.3	11.8%

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
5341	2001	PGR-1727	Kirovogradskih 2	23.9	14.5	18.6	2.4	11.8%
4666	2001	TMP-10870	Querandi Line 1	25.1	14.0	17.3	2.6	11.7%
4627	2001	TMP-10833	Line 8709-5-10	49.4	19.5	36.2	5.4	11.7%
4599	2001	TMP-10808	Rolin	55.0	20.0	42.3	6.1	11.6%
5418	2001	TMP-9861	S-MOBL	43.8	20.0	33.6	4.8	11.6%
5356	2001	PGR-14266	Dufferin	53.7	18.5	39.9	5.9	11.6%
5339	2001	PGR-1726	Kubanskij	25.2	13.0	18.8	2.6	11.6%
4661	2001	TMP-10865	Fr 681	36.5	15.5	27.6	3.8	11.4%
4592	2001	TMP-10801	AP 7	70.0	20.0	50.7	7.7	11.4%
5381	2001	TMP-10137	H39/B La Plata	19.1	14.5	16.1	1.8	11.3%
4651	2001	TMP-10856	AC Emerson	32.7	15.5	24.0	3.4	11.3%
5343	2001	PGR-1730	Donskoj 9	29.0	16.0	20.8	3.0	11.2%
4581	2001	TMP-9904	Banga	31.8	15.5	24.4	3.2	11.2%
4669	2001	TMP-10873	Dakota Line 8	27.0	17.0	19.1	2.6	11.1%
4635	2001	TMP-10841	Z 95575	48.1	20.0	34.2	5.0	11.1%
4680	2001		CHK - Vimy	35.9	19.0	26.9	3.7	11.0%
5384	2001	TMP-2735	Type 11	24.3	10.5	18.6	2.3	11.0%
4580	2001		CHK - Vimy	44.5	20.0		4.5	10.9%
4595	2001	TMP-10804	No name	56.5	20.0	39.8	5.9	10.9%
5401	2001		CHK - Vimy	15.7	18.5	11.9	1.4	10.9%
5385	2001	TMP-2755	No name	16.9	9.0	13.0	1.5	10.9%
5350	2001	PGR-11967	Mcgregor	47.4	17.5	35.3	4.8	10.8%
4588	2001	TMP-9911	Vaizhgantas	48.0	19.0	36.7	4.9	10.7%
4648	2001	TMP-10853	Verne	27.5	15.5	21.2	2.7	10.6%
4678	2001	TMP-10882	Line 93 Escalina	29.8	19.0	22.6	2.8	10.5%
4637	2001	TMP-10843	Z 95198	54.0	20.0	40.2	5.4	10.5%
5420	2001		CHK - Normandy	34.0	16.5	26.2	3.3	10.4%
4693	2001	TMP-10896	LM-95	17.0	12.5	12.9	1.5	10.4%
4684	2001	TMP-10887	L. 00-207	45.2	18.5	35.9	4.4	10.4%
5398	2001	TMP-2543	Sziciliai alajlen	20.5	18.5	15.7	1.8	10.3%
5417	2001	TMP-9858	Balabi	33.9	17.0	24.6	3.2	10.3%
4635	2001	TMP-10841	Z 95575	34.7	19.0	25.0	3.3	10.3%
5337	2001	PGR-1719	Barnaulsk	23.0	13.0	18.0	2.0	10.2%
4583	2001	TMP-9906	Blue Chip	18.0	13.5	12.5	1.5	10.1%
4696	2001	TMP-10052	Opaline	37.2	18.0	28.8	3.4	10.1%
4639	2001	TMP-10845	Taragur	32.6	18.5	22.0	3.0	10.1%
5346	2001	PGR-5035	Cree	28.4	18.0	20.7	2.6	10.1%
5389	2001	TMP-9981	Sel CIli -2085 (C4)	14.4	9.5	10.4	1.2	10.0%
5334	2001	TMP-10241	Victory Sel. No. 3256 (Norland)	25.6	18.5	19.7	2.3	10.0%
5396	2001	TMP-11346	Selection of Chaurra Olajlen (large seed)	37.3	13.5	28.1	3.4	9.9%
4683	2001	TMP-10886	L. 541-02	45.9	20.0	34.1	4.3	9.9%
5382	2001	TMP-2645	PI 780	25.0	11.5	18.6	2.2	9.9%
5387	2001	TMP-10102	Sel. of CIli-2082 (C4)	13.6	9.0	10.7	1.1	9.9%
4695	2001	TMP-10051	Mikeal	15.1	14.0	11.4	1.2	9.8%
5402	2001	TMP-10090	Sel. of CIli-2269 (C4)	23.3	20.0	16.9	2.0	9.8%
4691	2001	TMP-10894	A-163	32.0	15.0	25.0	2.9	9.8%
5369	2001	TMP-11340	noname	27.7	13.0	22.4	2.4	9.8%
5361	2001	PGR-14270	Raja	44.5	15.5	34.9	4.0	9.8%

PGRC Plot #	Year	TMP	Cultivar	Dry Wt (g)	Plant Height (cm)	Retted Dry Wt (g)	Retted Fiber Wt (g)	Fiber Content of Unretted Straw (%)
5419	2001	PGR-8234	Avangard	36.6	18.0	25.9	3.3	9.7%
560	2001		CHK - Normandy	42.0	18.0	34.2	3.7	9.6%
5348	2001	PGR-8230	Sibiriak	28.9	17.0	21.9	2.4	9.6%
4600	2001		CHK - Normandy	30.7	17.0	19.5	2.6	9.5%
5392	2001	TMP-10266	B. Golden x Redwing (blue)	44.2	16.5	33.3	3.9	9.4%
4662	2001	TMP-10866	Fr 646	32.5	19.5	25.0	2.8	9.4%
5410	2001	TMP-1424	No name	30.8	15.0	22.2	2.6	9.2%
5349	2001	PGR-8232	Kirovogradskij 2	35.1	18.0	23.2	3.0	9.1%
4585	2001	TMP-9908	Mikael	20.5	16.5	14.2	1.6	9.1%
5411	2001	TMP-1461	No name	43.7	20.0	32.9	3.7	9.0%
5342	2001	PGR-1729	Uspeh	27.2	14.5	20.1	2.2	9.0%
5391	2001	TMP-10094	Dehiscent	32.4	13.5	25.5	2.6	8.7%
4758	2001	TMP-10052	Opaline	16.4	14.0	11.7	1.2	8.7%
4700	2001		CHK - Normandy	18.2	12.5	13.9	1.2	8.2%
5395	2001	TMP-11345	Selection of Chaurra Olajlen (small seed)	27.0	10.5	20.4	2.0	8.1%
4760	2001		CHK - Normandy	28.7	14.0	20.6	2.1	8.0%
5388	2001	TMP-9980	Sel CIli -2085 (C2)	15.6	8.0	12.2	1.0	7.9%
5383	2001	TMP-2658	Sel. from C.I. 1802	24.5	10.0	19.2	1.7	7.7%
4642	2001	TMP-10847	Amason	23.3	14.5	16.8	1.5	7.5%
5406	2001	TMP-7661	N.D. 1844	22.8	13.5	16.2	1.5	7.4%
5345	2001	TMP-11338	Caldwell 32/Dillman	28.7	12.5	19.0	1.9	7.3%
4656	2001	TMP-10861	No 3896	29.4	16.0	22.3	1.9	7.2%
4652	2001	TMP-10857	Bison	19.9	14.0	15.6	1.2	7.0%
5344	2001	TMP-11337	Ghari 3	18.3	9.0	12.5	1.1	7.0%
5367	2001	TMP-11339	Ratodero 2	22.7	9.0	17.5	1.3	6.4%
4668	2001	TMP-10872	Linota Line 12	33.4	15.0	23.5	1.8	6.0%
5390	2001	TMP-2796	N.P. 16	30.9	10.0	21.0	1.7	6.0%
5409	2001	0	Selection of Winterlein	52.8	18.0	33.8	2.6	5.2%
5373	2001	TMP-10136	36W Winter Type	64.5	19.0	51.5	2.6	4.2%
5408	2001	0	Selection of Winterlein	55.8	16.5	35.8	1.2	2.3%
4759	2001	TMP-10052	Opaline	127.4	14.0	12.5	1.1	0.9%

Table A3. CDC Data From 2001 Canora F4 Lines Sorted on Fiber Content %

Row		Full *Row Wt (gm)*	Unretted Bundle Wt (gm)	Dry Retted Bundle Wt (gm)	Retted Fiber Wt (gm)	Fiber Content of Unretted Straw (%)
625	CDC Valour//Flanders/FP926	298.4	51.9	47.9	9.3	18.8%
1,070	McGregor/FP871//Somme/Flanders	190.3	29.0	27.4	4.9	18.4%
863	CDC Bethune//Flanders/FP908	346.1	52.7	47.1	9.0	18.0%
453	CDC Arras//Somme/Flanders	270.7	43.7	40.3	7.4	17.9%
1,069	McGregor/FP871//Somme/Flanders	285.8	48.6	43.5	8.2	17.8%
808	NorLin/Vimy//McGregor/FP871	187.2	26.6	24.8	4.3	17.6%
159	CDC Bethune//Vimy/FP907	139.2	22.8	21.1	3.5	17.1%
739	CDC Valour//Somme/FP923	241.7	38.7	34.2	6.1	16.9%
964	CDC Arras//NorLin/Vimy	358.5	53.4	48.9	8.6	16.8%
854	CDC Bethune//Flanders/FP908	235.2	34.1	31.3	5.3	16.7%
1,025	McGregor/FP871//Somme/Flanders	183.9	32.4	29.7	5.0	16.7%
861	CDC Bethune//Flanders/FP908	315.1	45.5	40.6	7.0	16.3%
138	CDC Bethune//Somme/Flanders	215.3	33.6	30.6	5.0	16.1%
774	NorLin/Vimy//McGregor/FP871	198.6	30.0	27.3	4.3	15.8%
182	CDC Bethune//Vimy/FP907	301.0	47.5	42.5	7.0	15.6%
819	NorLin/Vimy//McGregor/FP871	216.3	33.1	30.4	4.8	15.6%
846	NorLin/Vimy//McGregor/FP871	117.6	21.7	20.1	3.0	15.6%
1,078	McGregor/FP871//Somme/Flanders	327.4	50.4	44.4	7.4	15.4%
818	NorLin/Vimy//McGregor/FP871	267.5	43.4	40.1	6.2	15.2%
1,067	McGregor/FP871//Somme/Flanders	226.8	36.8	33.3	5.2	15.1%
1,072	McGregor/FP871//Somme/Flanders	254.6	37.7	35.1	5.3	15.1%
380	CDC Valour//Flanders/FP908	164.8	31.2	27.8	4.3	15.0%
1,047	McGregor/FP871//Somme/Flanders	243.5	39.2	35.6	5.5	14.9%
1,001	McGregor/FP871//Vimy/FP907	338.5	50.6	44.4	7.1	14.8%
870	CDC Bethune//Flanders/FP908	320.2	48.6	43.5	6.8	14.7%
1,026	McGregor/FP871//Somme/Flanders	171.6	29.5	27.2	3.9	14.5%
620	CDC Valour//Vimy/FP907	267.4	38.8	34.9	5.2	14.3%
1,023	McGregor/FP871//Somme/Flanders	305.0	53.5	49.4	7.3	14.3%
455	CDC Arras//Somme/Flanders	226.9	37.1	34.6	4.9	14.2%
3	CDC Normandy//Flanders/FP908	207.6	34.1	31.2	4.4	14.0%
220	CDC Bethune//Vimy/FP907	218.5	36.7	32.2	4.7	13.7%
851	CDC Bethune//Flanders/FP908	231.7	38.4	34.6	4.9	13.6%
766	CDC Bethune//NorLin/Vimy	389.7	58.3	52.3	7.6	13.6%
118	CDC Bethune//Somme/Flanders	151.2	27.4	24.8	3.4	13.6%
1,046	McGregor/FP871//Somme/Flanders	261.1	45.5	40.2	5.8	13.5%
787	NorLin/Vimy//McGregor/FP871	163.2	26.1	24.4	3.1	13.2%
272	CDC Bethune//Somme/FP923	283.7	39.4	35.0	4.8	13.0%
171	CDC Bethune//Vimy/FP907	285.9	46.3	41.4	5.5	12.6%
1,060	McGregor/FP871//Somme/Flanders	276.6	46.4	40.6	5.5	12.6%

Row		Full *Row Wt (gm)*	Unretted Bundle Wt (gm)	Dry Retted Bundle Wt (gm)	Retted Fiber Wt (gm)	Fiber Content of Unretted Straw (%)
221	CDC Bethune//Vimy/FP907	198.6	31.5	27.5	3.6	12.4%
994	CDC Arras//NorlLin/FP871	165.9	25.3	23.1	2.8	12.3%
1,043	McGregor/FP871//Somme/Flanders	253.3	40.0	36.3	4.6	12.3%
777	NorLin/Vimy//McGregor/FP871	189.8	29.1	26.7	3.2	12.0%
32	CDC Bethune//McGregor/FP871	288.4	48.0	44.0	5.4	11.9%
225	CDC Bethune//Vimy/FP907	201.1	33.3	30.1	3.6	11.8%
433	CDC Arras//Somme/Flanders	156.5	28.0	25.4	2.9	11.3%
134	CDC Bethune//Somme/Flanders	182.7	33.8	31.1	3.3	10.6%
40	CDC Normandy//Flanders/FP908	148.3	25.1	22.6	2.3	10.0%
16	CDC Bethune//McGregor/FP871	213.7	39.2	35.0	2.9	7.9%

Table A4. Comparison of Estimated Bast Fiber Content Using NIR-Based Equation Results and Biolin Retting Results

Number	Biolin Plot #	Accession Name	Donor Institute	Position	Est by USDA 11-25 no corr.	Est by USDA 11-25 (+0.035)	Est by USDA 11-25 (103.5%)	Shive %	err %	Fiber % on Unretted - Biolin	Biolin Ranking on Unretted wt	Difference USDA vs Biolin /a	%diff
2810TMP	2810	Raisa	Morden Research Station	8.00	21.2%	24.7%	22.0%	71.5%	-5.6%	26.7%	1	4.7%	21.3%
3142TRZ	3142	Fany	Russia, Torzok	31.00	19.4%	22.9%	20.0%	71.1%	-0.5%	23.5%	2	3.5%	17.3%
3118TRZ	3118	Ariane	Russia, Torzok	28.00	20.0%	23.5%	20.7%	73.4%	-1.6%	23.1%	5	2.4%	11.4%
2814TMP	2814	Marina	Morden Research Station	11.00	18.8%	22.3%	19.4%	71.6%	0.2%	23.1%	4	3.7%	18.9%
3162TRZ	3162	G-1847-4-1	Russia, Torzok	32.00	21.4%	24.9%	22.1%	73.9%	-3.7%	23.1%	3	1.0%	4.7%
2807TMP	2807	Alexim	Morden Research Station	7.00	19.8%	23.3%	20.4%	71.6%	0.2%	22.6%	6	2.1%	10.3%
2800TMP	2800	Ariane	Morden Research Station	6.00	18.0%	21.5%	18.7%	73.0%	1.6%	20.5%	7	1.8%	9.6%
3140TRZ	3140	Regina	Russia, Torzok	30.00	18.0%	21.5%	18.7%	75.4%	0.2%	19.5%	8	0.9%	4.8%
3054VAV	3054	1-ol 1(ex V437)	Vavilov Institute	18.00	19.4%	22.9%	20.0%	76.6%	0.0%	19.2%	9	-0.8%	-4.1%
3091TRZ	3091	No. 422	Russia, Torzok	23.00	18.1%	21.6%	18.7%	78.4%	-2.4%	18.4%	10	-0.3%	-1.8%
3079TRZ	3079	Prochovskij district	Russia, Torzok	20.00	18.5%	22.0%	19.1%	81.1%	-4.7%	18.3%	11	-0.8%	-4.4%
2812TMP	2812	Elise	Morden Research Station	9.00	17.4%	20.9%	18.0%	71.7%	5.1%	18.2%	12	0.2%	1.2%
3120TRZ	3120	SV-65-080	Russia, Torzok	29.00	17.5%	21.0%	18.1%	76.5%	1.6%	17.8%	13	-0.3%	-1.5%
2819TMP	2819	AC Carnduff	Morden Research Station	14.00	17.3%	20.8%	17.9%	77.5%	0.3%	17.6%	14	-0.3%	-1.5%
3103TRZ	3103	no name	Russia, Torzok	25.00	17.8%	21.3%	18.4%	76.1%	2.0%	17.4%	15	-0.9%	-5.0%
2813TMP	2813	Natasja(EU)	Morden Research Station	10.00	18.3%	21.8%	19.0%	73.9%	4.5%	17.3%	16	-1.7%	-8.8%
2748WI	2748	Martin	0	1.00	18.6%	22.1%	19.3%	77.9%	0.1%	17.2%	17	-2.1%	-11.0%
3104TRZ	3104	Suenaga	Russia, Torzok	26.00	15.7%	19.2%	16.2%	75.5%	2.9%	17.1%	18	0.8%	5.1%
3169TRZ	3169	Orshanskij 2	Russia, Torzok	33.00	18.1%	21.6%	18.8%	77.2%	1.8%	17.0%	20	-1.7%	-9.3%
2785TMP	2785	CDC Bethune	SeCan Association	2.00	17.3%	20.8%	17.9%	76.0%	3.0%	17.0%	19	-0.9%	-4.8%
2869DEU	2869	Ottawa 2152	Germany, Gatersleben	16.00	19.1%	22.6%	19.8%	82.0%	-3.1%	16.8%	21	-3.0%	-15.0%
3083TRZ	3083	Mocovi	Russia, Torzok	21.00	16.2%	19.7%	16.7%	80.4%	-1.8%	16.7%	22	0.0%	-0.1%
2787TMP	2787	FP 980	University of Sask. (CDC)	3.00	16.9%	20.4%	17.5%	81.2%	-1.8%	16.5%	23	-1.0%	-5.8%
2816TMP	2816	Vimy	University of Sask. (CDC)	12.00	17.6%	21.1%	18.2%	75.9%	4.0%	16.4%	26	-1.9%	-10.2%
3111TRZ	3111	no name	Russia, Torzok	27.00	15.6%	19.1%	16.1%	79.7%	-0.1%	16.4%	25	0.3%	1.8%
3084TRZ	3084	L-93-1	Russia, Torzok	22.00	19.1%	22.6%	19.7%	80.9%	-1.6%	16.4%	24	-3.3%	-16.6%
3245FL	3245	no name	USDA-ARS-Northern Crop Science Lab	34.00	12.8%	16.3%	13.3%	77.9%	1.7%	16.0%	28	2.7%	20.2%
2790TMP	2790	CDC Normandy	University of Sask. (CDC)	4.00	16.7%	20.2%	17.2%	79.4%	0.8%	16.0%	27	-1.2%	-7.0%
3076TRZ	3076	Karnobat-263	Russia, Torzok	19.00	18.6%	22.1%	19.2%	80.4%	-2.2%	15.9%	29	-3.3%	-17.2%
3017VAV	3017	CH.L.2973	Vavilov Institute	17.00	15.9%	19.4%	16.5%	78.6%	1.7%	15.6%	30	-0.9%	-5.4%
2791TMP	2791	CDC Triffid	University of Sask. (CDC)	5.00	20.6%	24.1%	21.3%	80.3%	0.1%	15.5%	31	-5.7%	-27.0%

Number	Biolin Plot #	Accession Name	Donor Institute	Position	Est by USDA 11-25 no corr.	Est by USDA 11-25 (+0.035)	Est by USDA 11-25 (103.5%)	Shive %	err %	Fiber % on Unretted - Biolin	Biolin Ranking on Unretted wt	Difference USDA vs Biolin /a	%diff
3099TRZ	3099	363-4	Russia, Torzok	24.00	17.2%	20.7%	17.8%	79.0%	1.2%	15.4%	33	-2.4%	-13.4%
2817TMP	2817	AC McDuff	Morden Research Station	13.00	17.2%	20.7%	17.8%	76.8%	3.9%	15.4%	32	-2.4%	-13.7%
2820TMP	2820	AC Linora	Indian Head Research Farm	15.00	14.2%	17.7%	14.7%	77.9%	4.8%	14.2%	34	-0.5%	-3.3%
		Total				726.9%				617.8%			
		Average				21.4%				18.2%			
		St.Dev.				0.02				0.03			
		CV				9%				16%			

a/ Difference is calculated by using the USDA Adjusted Fiber Content (103% of original) vs. Biolin Research manual findings

Note: The estimated USDA equations are only linear equations. Quadratic and/or transformation equations may give better fits but these will be tried only after new correction functions are estimated by the USDA lab.

Equation A1. Fiber % of Unretted PGRC Straw = f()

Regression Statistics	
Multiple R	0.24
R Square	0.06
Adjusted R Square	0.06
Standard Error	0.04
Observations	631.00

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.00	0.06	0.06	39.48	0.00
Residual	629.00	0.99	0.00		
Total	630.00	1.05			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	12.4%	0.00	41.16	0.00	0.12	0.13	0.12	0.13
2000 = 1	**2.2%**	**0.00**	**6.28**	**0.00**	**0.02**	**0.03**	**0.02**	**0.03**

NOTE: Year 2001 was used as intercept

Equation A2. Fiber % of Unretted PGRC Straw in 2001 = f()

Regression Statistics	
Multiple R	0.50
R Square	0.25
Adjusted R Square	0.24
Standard Error	0.03
Observations	174.00

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3.00	0.05	0.02	19.10	0.00
Residual	170.00	0.16	0.00		
Total	173.00	0.21			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	13.9%	0.00	32.31	0.00	0.13	0.15	0.13	0.15
Height 19.5 - 23.0 cm	(0.1)%	0.01	(0.22)	0.83	(0.01)	0.01	(0.01)	0.01
Height 15.0 - 18.5 cm	**(2.1)%**	**0.01**	**(3.43)**	**0.00**	**(0.03)**	**(0.01)**	**(0.03)**	**(0.01)**
Height < 15.0 cm	**(4.4)%**	**0.01**	**(6.75)**	**0.00**	**(0.06)**	**(0.03)**	**(0.06)**	**(0.03)**

NOTE: Height 18.5 - 19.5 cm was used as intercept

Equation A3. Fiber % of Unretted PGRC Straw in 2000 = f()

Regression Statistics	
Multiple R	0.21
R Square	0.05
Adjusted R Square	0.04
Standard Error	0.04
Observations	457.00

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3.00	0.04	0.01	7.20	0.00
Residual	453.00	0.75	0.00		
Total	456.00	0.78			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	15.1%	0.00	55.92	0.00	0.15	0.16	0.15	0.16
Height < 15.0 cm	**(5.9)%**	**0.01**	**(4.28)**	**0.00**	**(0.09)**	**(0.03)**	**(0.09)**	**(0.03)**
Height 15.0 - 18.5 cm	**(0.9)%**	**0.00**	**(2.21)**	**0.03**	**(0.02)**	**(0.00)**	**(0.02)**	**(0.00)**
Height 19.5 - 23.0 cm	(0.1)%	0.01	(0.19)	0.85	(0.01)	0.01	(0.01)	0.01

NOTE: Height 18.5 - 19.5 cm was used as intercept

Equation A4. Fiber % of Unretted PGRC Straw in 2000 and 2001 = f()

Regression Statistics	
Multiple R	0.39
R Square	0.15
Adjusted R Square	0.15
Standard Error	0.04
Observations	631.00

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5.00	0.16	0.03	22.63	0.00
Residual	625.00	0.89	0.00		
Total	630.00	1.05			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	13.6%	0.00	36.15	0.00	0.13	0.14	0.13	0.14
Height > 23.0 cm	**7.6%**	**0.02**	**3.47**	**0.00**	**0.03**	**0.12**	**0.03**	**0.12**
2000 = 1	**1.4%**	**0.00**	**3.84**	**0.00**	**0.01**	**0.02**	**0.01**	**0.02**
Height 19.5 - 23.0 cm	0.0%	0.00	0.06	0.96	(0.01)	0.01	(0.01)	0.01
Height 15.0 - 18.5 cm	**-1.1%**	**0.00**	**(3.14)**	**0.00**	**(0.02)**	**(0.00)**	**(0.02)**	**(0.00)**
Height < 15.0 cm	**-4.4%**	**0.01**	**(6.95)**	**0.00**	**(0.06)**	**(0.03)**	**(0.06)**	**(0.03)**

NOTE: Height 18.5 - 19.5 cm and 2001 was used as intercept